POWER PLANT ENGINEERING

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Making Steam for a Large State Institution

NEW POWER PLANT AT THE CENTRAL ISLIP STATE HOSPITAL MEETS DIVERSIFIED LOAD REQUIREMENTS

OUT ON LONG ISLAND, approximately midway between Coney Island and Montauk, there is situated a vast state institution occupying over 1000 acres of ground and composed of some 130-odd buildings. This is known as the Central Islip State Hospital for the insane and is one of the 13 institutions of its kind in the state of New York. It has a normal population of 5500 patients and 1000 employes.

FIG. 1. VIEW IN THE NEW BOILER ROOM

As might be expected, the power requirements at an institution of this type are extremely diversified. Power is required not only for light and heat, but also for refrigeration and for pumping purposes. Considered as a whole, with its laundries, kitchens, bakeries, creameries, and fire department, it resembles a small city in every respect except, perhaps, in that of government. The power plant, therefore, must be a combination central heating and pumping plant and electric generating station.

The design and operation of a plant serving an institution such as this, however, may differ in some respects from an ordinary commercial or industrial plant. This is due to the fact that a certain amount of hand labor is available in the form of patients. It is possible, therefore, to do certain things by hand in a plant of this kind which would not be economically possible in an industrial plant where all hand labor is more or less costly.

In spite of this fact, very little hand labor is resorted to at Central Islip, and while a number of

patients do work in the power plant, automatic equipment has been installed wherever possible.

General Features

The institution is served by two power plants known as the North and South Colony plants. The North Colony plant is an old plant while South Colony Plant with which this article is concerned is a new plant. While both plants furnish light, heat and power, South Colony is primarily a steam plant, the only electricity generated being direct current for lighting purposes in the nearby buildings. At North Colony, alternating current is generated for power and light. The

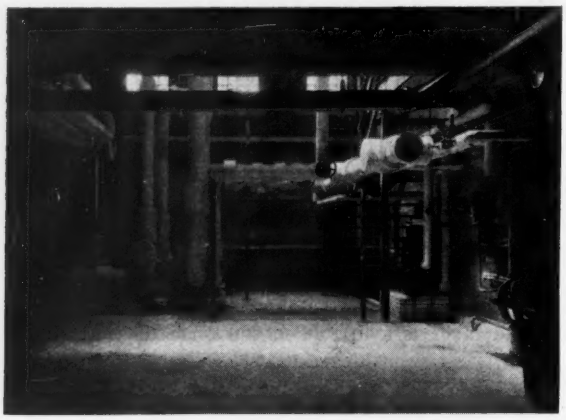


FIG. 2. THE BOILER FEED PUMPS IN THE BASEMENT OF THE PUMP HOUSE

two plants are located at opposite ends of the institution grounds and are approximately a mile apart.

Although, in the foregoing paragraph, South Colony plant has been referred to as a new plant, this is, perhaps, not entirely correct. The new boiler house at South Colony was built to replace an old plant which has since been dismantled, the former site of which, however, may be noted by reference to Fig. 6. The old engine room is still in service, and, as stated before, furnishes direct current to a limited number of buildings, mostly for lighting purposes.

The New Boiler House

The new boiler house is a substantial building, of modern design, constructed entirely of brick, steel and concrete and lighted by large windows. It is 120 ft. in length, 80 ft. wide and approximately 50 ft. high. The plans for the plant were worked out under the direction of L. F. Pilcher, state architect of New York.

The boilers are arranged on opposite sides of the building with the firing aisle between as may be noted in Fig. 1. The overhead coal bunkers were placed high above the boiler room floor so as to secure as much natural illumination as possible through the doors and windows at the opposite ends of the building. Although the plans for the ultimate layout call for the installation of eight boilers, at the present time only four are installed. The others will be added as the load requirements increase.

Coal and Ash Handling Equipment

The coal and ash handling machinery provided is exceptionally well designed and possesses a number of interesting features. A side elevation of the system is shown in Fig. 7. As will be noted, two receiving hoppers are provided, one a track hopper into which railroad cars on a trestle deliver the coal and the other, an auxiliary hopper installed at grade level for handling the coal reclaimed from storage. Both hoppers are enclosed in order to reduce the spreading of dust when coal is being handled.

From the receiving hoppers, the coal falls by gravity onto an apron conveyor which carries it up a slight incline to a Jeffrey double-roller crusher, installed in a separate crusher house. The crushed coal is next delivered to a pivoted bucket conveyor which carries it to the upper part of the boiler room where through the agency of a movable tripper it is discharged into the overhead bunkers. The apron conveyor and the crusher are operated by a single electric motor rated at 30 hp. The pivoted bucket conveyor has a capacity of 60 T. per hr. and is driven at its upper end by a 20 hp. motor.

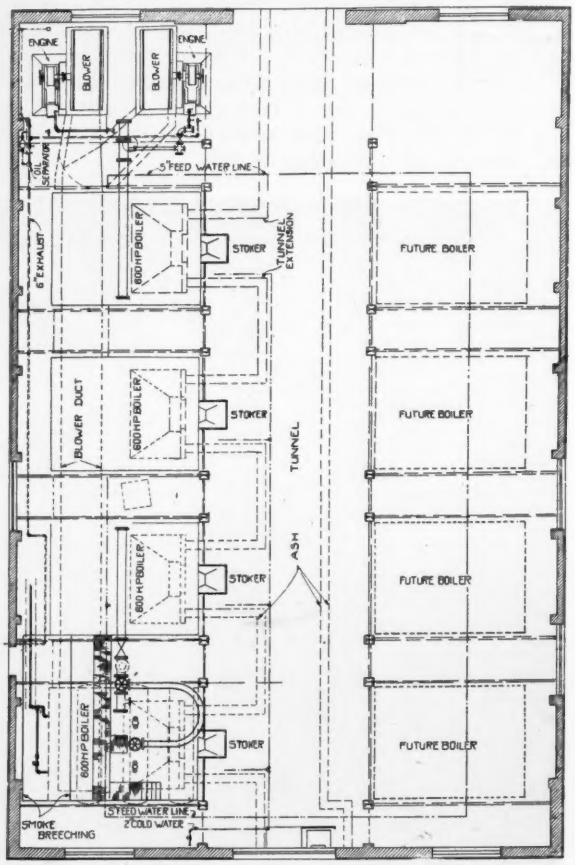


FIG. 3. PLAN OF BOILER ROOM FLOOR

Coal and ash handling is nearly all of Jeffrey manufacture and was installed by the Guarantee Construction Co.

The coal bunkers are of the parabolic type, made of steel, lined with 3 in. of concrete and suspended from 18-in. I-beams above. They have a capacity of 500 T.

Coal is withdrawn by gravity through openings in the bottom of the bunker and by means of a 1-T. electrically operated weigh larry, is distributed to the individual stoker hoppers. The larry is fitted with Fair-

banks scales which automatically record the weight of each load handled. Over 30,000 T. of coal are burned every year at this institution.

Ashes is withdrawn from the ash pits below the firing floor and loaded directly into small hand cars.

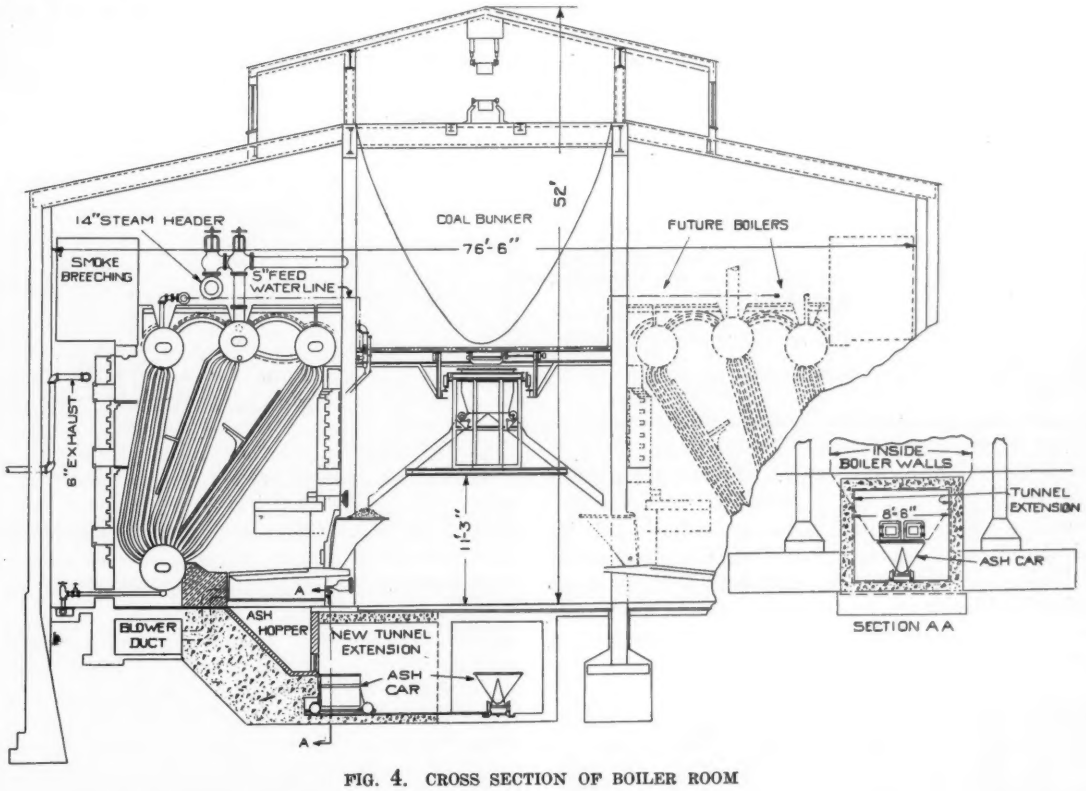


FIG. 4. CROSS SECTION OF BOILER ROOM

These hand cars operate over a simple system of tracks in a tunnel underneath the boiler room. At one end of this tunnel, the ash cars discharge into a skip bucket as shown in Fig. 9 which, when elevated to its upper

FIG. 5. ONE OF THE FORCED DRAFT FANS

position discharges the ashes into a 1900-cu. ft. concrete lined, steel ash bin.

The skip has a capacity of one ton and is operated by a 10-hp. electric motor installed in a small outhouse to protect the machinery from the weather.

Boiler Equipment

At the present time, steam is generated at a normal pressure of 120 lb. gage, in four 600-hp. Stirling boilers. The water level in three of the boilers is controlled by Watts regulators while on the fourth, Copes regulators

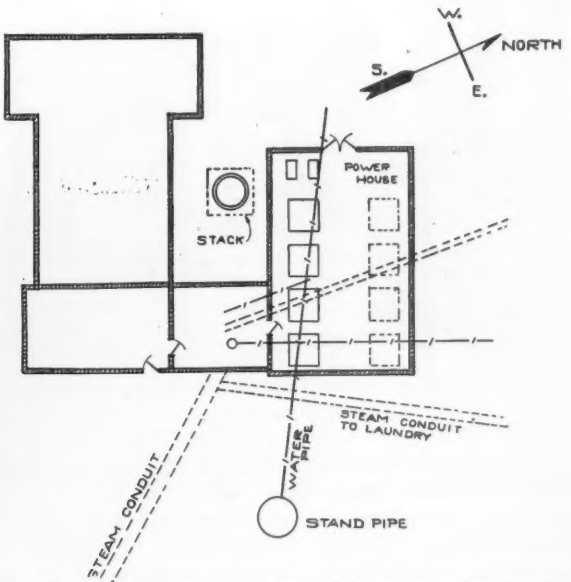


FIG. 6. PLAN SHOWING RELATIVE LOCATION OF NEW BOILER HOUSE

are installed. The output of each boiler is measured by a General Electric Co. steam flow meter installed on the boiler fronts as shown in Fig. 1.

The boilers are set singly and are equipped with Jones Underfeed Stokers of the six-retort type. Forced draft is supplied to all furnaces through a common duct, by either of two Clarage fans, located as shown on the plan view of the boiler room, Fig. 3. Each fan is driven by a Jones Troy, horizontal engine, which also drives the stoker line shaft operating the Cole regulators controlling the speed of the stokers. Mason regulators are installed in the steam lines of the fan engines.

Dayton-Dowd centrifugal pumps. These are rated at 450 g.p.m., 404 ft. head, and are driven at 2300 r.p.m. by Terry turbines.

All returns from the heating system and other steam using apparatus except that which goes directly to the feed water heater is delivered into a large tank in the pump room, into which deep well water for make-up purposes is also pumped. Two pumps, one a Canton-Hughes 12 by 7 by 12-in. and the other a Worthington

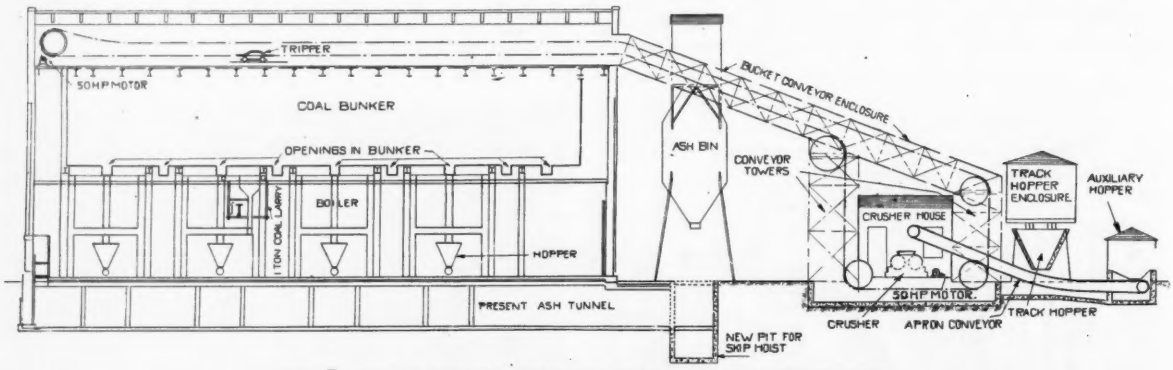


FIG. 7. SIDE ELEVATION SHOWING COAL HANDLING EQUIPMENT

Draft pressure in the furnaces is indicated by 3-in-1 draft gages made by the Precision Instrument Co. Under normal operating conditions, 3 in. of draft is maintained below the grates while as small a negative pressure as possible is carried in the combustion chamber.

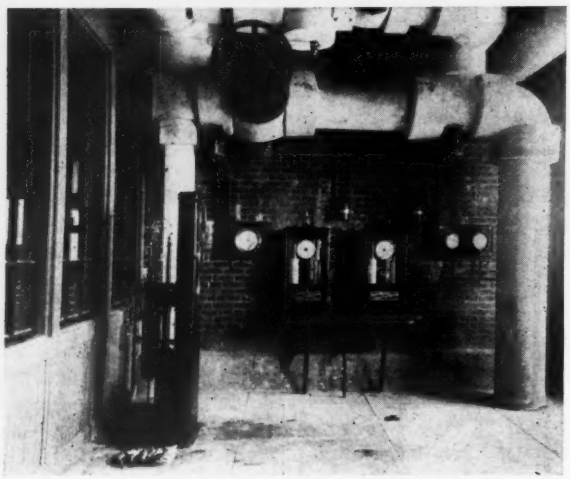


FIG. 8. VIEW IN CHIEF ENGINEER'S OFFICE SHOWING INSTRUMENTS

In addition to the usual boiler fittings, such as water columns, stop and check valves, safety valves, and blow-off valves, the boilers are each fitted with five units of Diamond Soot Blowers. Draft above the grates is secured by a stack 150 ft. in height, constructed by the Rust Engineering Co.

Feed Water

Feed water which is taken from a number of artesian wells, is heated in a 5000-hp. Cochrane feed water heater and is delivered into the boilers by two 12 by 7 by 10-in., take suction from the condensate return tank and deliver the water to the feed water heater. From here, the two feed pumps described above send it into the boilers.

Two Sims domestic water heaters are provided, each having a capacity of 15,000 g.p.hr. These heaters are of the closed type, heated by exhaust steam, and raise the temperature of the water from around 50 deg. F. to about 180 deg. This water is used for general domestic purposes and is circulated in the system by a small Dayton-Dowd centrifugal pumps.

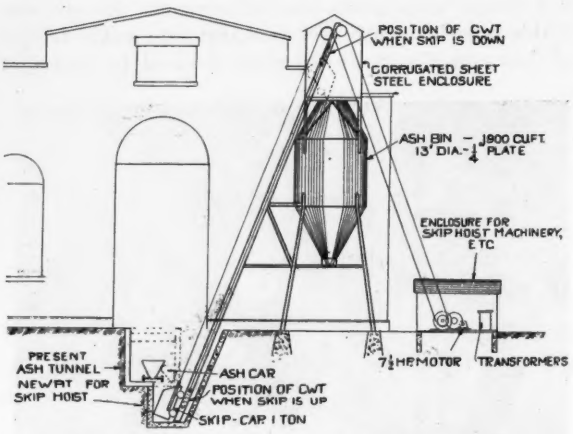

POSITION OF CWT WHEN SKIP IS DOWN
CORRUGATED SHEET STEEL ENCLOSURE
ASH BIN — 1800 CU FT
13' DIA. - 1/4 PLATE
ENCLOSURE FOR SKIP HOIST MACHINERY, ETC
PRESENT ASH TUNNEL
NEW PIT FOR SKIP HOIST
ASH CAR
POSITION OF CWT WHEN SKIP IS UP
SKIP-CAP 1 TON
7½HP MOTOR
TRANSFORMERS

FIG. 9. ELEVATION OF SKIP HOIST USED IN HANDLING ASHES

A booster heater, located directly above the two domestic heaters, receives a certain amount of water from the latter and raises the temperature from 180 deg. to 200 deg. for laundry purposes.

All water heaters, pumps and other auxiliary apparatus is installed in a pump house, apart from the boiler room proper. A view of the boiler feed pumps and the

deep well make-up water pumps, as installed in the basement of the pump house, is shown in Fig. 2. As may be noted from this photograph, all pipe lines and associated equipment are covered with a heavy coating of 85 per cent magnesia insulation, to reduce radiation losses to a minimum.

In winter, all exhaust steam is used for heating purposes. In summer, however, there is an excess, and while a considerable amount of steam is used for heating water and for laundry and cooking purposes, that which is not so used is exhausted to the atmosphere.

The Engine Room

A view in the engine room of South Colony plant is shown in Fig. 10. The two generating units at the left are both Watertown units rated at 150 hp. and direct connected to two Sprague direct current generators rated at 100 kw., 125 v., 800 amp., 250 r.p.m.

The machine shown at the right is also a Watertown unit direct connected to a Sprague direct current generator. This, however, is a 60-hp. engine with the generator rated at 35 kw.

In referring to the engine room, it must be remembered that it is part of the old plant the boiler room of which has been demolished. The engine room equipment, therefore, while still in efficient condition is not

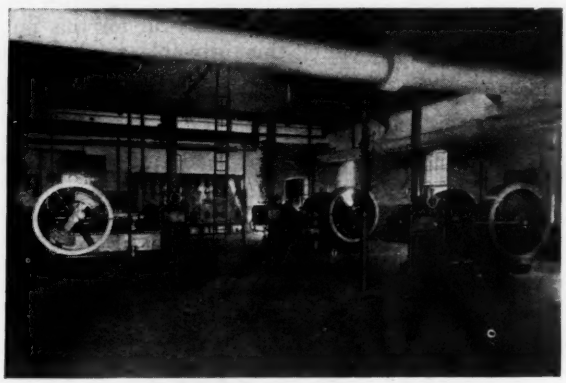


FIG. 10. VIEW IN THE ENGINE ROOM

of the most modern type. As in all combined power and heating plants the operation of the engines represents a distinct saving through the use of the exhaust steam for heating purposes. Steam for heating would be needed in any case, and by employing the engines as reducing valves, the electric power generated may be considered to a certain extent as a by-product.

Instruments

For recording operating performance and to aid in keeping the efficiency of the plant at its highest point, there is installed a complete set of recording and indicating instruments. While most of these are located near the equipment with which they are associated, a number of them are located on panel boards in the chief engineer's office.

Besides various pressure gages for indicating water and steam temperatures and pressures, there is installed the following:

1 1900 cu. ft. per hr. Venturi meter.

2 Precision Simmance Abady CO_2 Recorders.

1 Precision Instrument Co. recording thermometer, for recording domestic hot water temperatures.

1 Brown recording thermometer, for feed water temperature.

1 Brown indicating and recording pyrometer for flue gas temperatures. This instrument is located in the chief engineer's office and is associated with a form of switchboard by means of which the temperatures at any particular boiler may be tested.

A view in the chief engineer's office, showing the Venturi meter and the CO_2 recorders is shown in Fig. 8.

At the time data for this article was collected the plant, although in operation, had not been entirely completed. Many of the finer details still remained to be worked out. With the type of equipment installed and the instruments provided to check operating performance, this plant gives promise of reaching an efficiency as high as can be attained in any plant of its type.

In conclusion, we wish to express our indebtedness to the New York State Hospital Commission at Albany and to Dr. G. A. Smith, superintendent of the institution, for the many privileges extended which made possible the preparation of this article.

Notes on Wind Motors

By Robert Grimshaw.

WIND MOTORS were among the earliest employed; and in some countries—notably Holland, in which country there is one point from which 90 can be seen—their use is a feature of the minor local industries. Their advantages are:

1. Simplicity
2. Low first cost of instalment
3. Almost no operating cost
4. Low depreciation
5. Independence of fuel supply.

Their principal disadvantages are:

1. Uncertainty of power
2. Variations in power
3. Limited capacity
4. Difficulty of control of amount of power.

The first and second disadvantages are partly done away with when the windmill is supplemented by a reservoir for water pumped, or by storage batteries for electricity generated by a dynamo driven by the mill.

The latter arrangement, however, introduces complications and partly neutralizes the advantages above enumerated.

The maximum efficiency of a good windmill is only about 35 per cent. As, however, the wind costs nothing, the loss of the other 65 per cent is potential, rather than actual.

The largest wind wheels constructed are about 60 ft. in diameter.

About the only man who can sit at ease before the fire and smoke his pipe comfortably is the laborer, whose work ceases when the whistle blows. The work of the man whose brains are his tools is never done.—Business in Farming Bulletin.

Brickwork

Use of Arches and Elbows for Perfecting Combustion Conditions. By Zuce Kogan

BRICKWORK for furnaces of the steam generators is an immensely important factor in the economical combustion of fuel. Brickwork is no longer used simply for the purpose of limiting the space of the spreading of fire, but advanced study has demonstrated that it is one of the essential factors in the efficient utilization of fuel, and must be properly designed and installed. This use resulted from studying the needs of different fuels, and from designing furnaces in a manner to suit the different requirements. These requirements are numerous, but the three most important are:

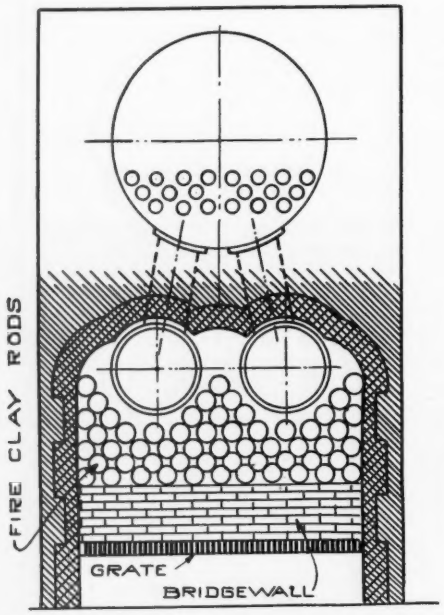


FIG. 1. BOILER FURNACE WITH FIRE CLAY RODS OVER BRIDGEWALL

1. Heating the gases that rise from the fuel bed unburned.
2. Reflecting some heat back on the fuel bed for securing constant ignition.
3. Concentrating the heat from the rear end of the grate on the fresh fuel.

Some other requirements are: Increasing the length of the combustion chamber by giving it a crooked shape as sometimes done with very moist fuels, thus giving more time for combustion of the gases; for the purpose of deflecting the hot gases so that they will give off the greatest quantity of heat to the boiler shells.

Furnace brickwork is usually required to fulfill all these purposes, but some fuels, some grates and some special installations require more attention to one of these services than to the others, therefore this requires still greater care in the design. Generally speaking, the effect of brickwork that influences the combustion of fuel is not as noticeable as when moist fuels are used. With the latter, where an efficient drying and quick ignition is required, the increase in efficiency relies to a greater extent on the furnace brickwork, and its proper arrangement is therefore still of greater importance as when compared with the ordinary used fuel. To arrange the brickwork so as to prevent any unburnt gases from passing out of the furnace, requires intimate knowledge and extreme care with almost any kind of fuel, as this is one of the most essential factors for the economical combustion of the fuel. Therefore in order to discuss the points to be considered with the different requirements, we will refer to each of these principal ones.

Preventing the Escape of Unburned Gases

Prevention of combustible gases from passing the bridgewall is a question that has been met and solved to a certain extent by the use of firebricks at the bridgewall passage in such a manner as to result in large surface area and to oblige the gases to spread in thin films. The gases under such conditions come in contact with the large surface of the highly heated bridgewall and ignite, resulting in complete combustion. This method of heating gases resulted in many different shapes and arrangements of bridgewalls, but nearly all of them were found successful for this purpose. An application of this principle is shown in Fig. 1, in which case a number of fire clay rods placed on top of the bridgewall, fills the space the whole width of the bridgewall to the center of the boilers. The spacing of these fire clay rods is such that it does not unduly restrict the draft. Other installations for insuring complete combustion of the gases are built up of conical shaped tiles instead of rods, in which case the gases will enter the large ends of the tiles, and pass out at the narrower openings, which increases their velocity and gives better contact with the hot bricks against which they impinge for ignition.

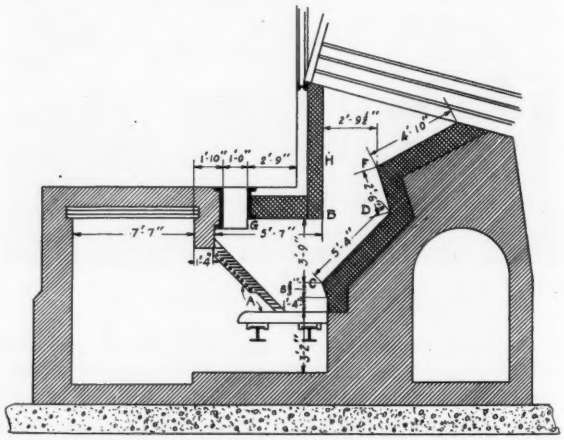


FIG. 2. FURNACE DESIGNED TO BURN FUEL CONTAINING 50 PER CENT MOISTURE

Although these provisions are quite effective and of general practice, they possess many disadvantages. First, the melting of brickwork, which is well known. The ignition of the gases produces an intense flame,

especially under a high per cent of rating where the temperature approaches 3000 deg. F., which is within a few hundred degrees of the temperature at which pure fire clay melts. Second, the friction loss due to the passing of the gases through these bridgewall arrangements gives a drop in draft, and to maintain the necessary new draft is sometimes too expensive.

A simpler and very effective arrangement which also eliminates at the same time the inconvenience of these complicated ignition bridgewalls, is shown in Fig. 2. In this case, the gases from the grate A passing through B fill this restricted passage B with a very hot flame, the brickwork C D F is designed to reflect the passing heat onto the brickwork G H, so that this reflection of intense heat may catch any unburnt gas in the way. Moreover D F is arranged in such a manner that the fire coming from the grate, strikes it and

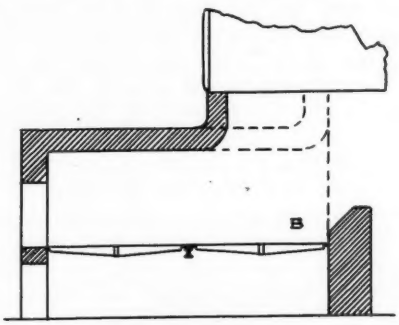


FIG. 3. ARCH SUITABLE ONLY FOR COKING METHOD OF FIRING

brings it into an incandescent state; while the gases, as may be noted from this figure, will strike this elbow and will be ignited. It has been suggested that the brickwork G H should be arranged in such a manner as to aid in reflecting back any heat rays coming from C D F so as to produce a constant reflection of heat rays from one brickwork to the other, thus assuring a better effect of this heat on the escaped gases.

Reflection of Heat for Constant Ignition

The arrangement of brickwork above the fuel bed possesses many interesting advantages that are worthy of consideration. When such brickwork or arches exist, the fire obtained by the combustion of fuel underneath them produces an intense heat, bringing them to an incandescent state. The heat is reflected from these arches back onto the fuel bed, thus perpetuating ignition. Arches properly installed for this purpose not only give greater economy but also permit obtaining a higher per cent of rating. The success obtained depends on the proper design of these arches, which brings under consideration the following important points:

1. The length of fuel bed to be covered.
2. The most desirable shape of the arch.
3. The most desirable distance of the arch from the fuel bed.

Considering the portion of fuel bed to be covered by the arch, we can easily understand that the more it covers, the higher will be the temperature and the quicker will the fuel ignite. Many designers, however, still design furnaces in the way illustrated in Fig. 3 so as to minimize space and expense in construction of these arches. This advantage must be considered in connection with the method of firing. As well known, some firemen throw the fresh fuel at the front of the furnace, others at the rear end near the bridgewall. Now if the fresh fuel be laid at the rear end at B, Fig. 3, the arch will not aid ignition.

Referring to the shape to be given to these arches, we can design them either as circular or flat. Considering the circular form, it may be said that this is of advantage when under a certain furnace arrangement, while it is the contrary with another kind of installation. Considering the question of heat radiated by the circular arches, we know it to be more intense at the end of the arch than at the center; this therefore helps to consume the fuel at the sides much quicker, thus leaving the fuel bed on this part of grate thinner, and admitting a greater amount of air. Generally, most of the flat stokers have their fuel distributed evenly on the whole breadth of the grate, therefore the circular designed arch becomes impractical in this case. Some stokers however, need these circular arches for an even combustion of fuel on the grate.

Considering the underfeed stoker illustrated in Fig. 4, the fuel tends to the sides of the walls, due to the inclination of the grate at its sides. Such an accumulation of thick fuel layers near the ends is, however, more usually found with higher per cent of ratings. The circular arches, therefore, tend to increase the rate of combustion and this is of special importance in this case, as the portion of the arch at the center is always much hotter with this stoker and therefore to equalize

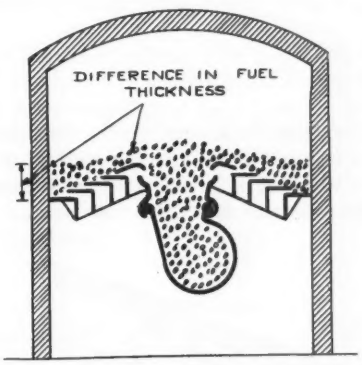


FIG. 4. CIRCULAR ARCH OVER UNDERFEED STOKER

combustion on the grate, this circular arch becomes of advantage. It can also be used to advantage in the case of fuels which slide on inclined grates and tend to pile up at the lower end of the grate. The distribution of fuel also depends on the position and working of the hoppers and grates and the shapes of the arch must be designed accordingly.

Considering the flat type of arch, its radiation of heat is more uniform throughout the whole area and therefore it is better adapted to cases where the thickness of the fuel bed is uniform. Moreover, the flat suspended arches will hold up for a longer time under increased temperature, and also are stronger due to the elimination of side thrust which is present in the sprung type. In modern design, the free suspension of fire bricks makes them independent of adjacent tile when one of them is deteriorated, while even the damaged one could be easily replaced by a simple operation, thus saving time and expense.

Considering the most desirable height of the arch, we have first of all to leave the question of radiation, and to take into account the height necessary for the proper combustion of the particular kind of fuel. From this point of view, the height must therefore be determined from the surface of the fuel bed instead of from the grate, and must be based on the kind of fuel, grate, rating per cent, and manner of charging the fuel.

Concentration of Fire on Green Fuel

The reflection of heat by the arches helps very much in igniting the fuel and burning it quickly. When a fresh layer of fuel is laid on the existing fire, it is chilled, the temperature of the arch is reduced, and the

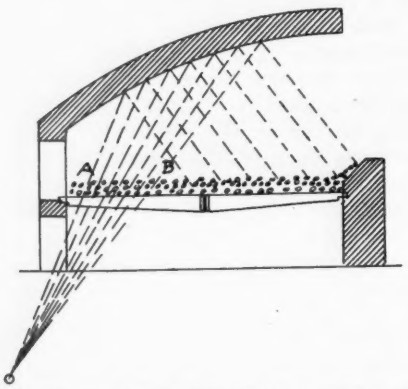


FIG. 5. ARCH FOR CONCENTRATING HEAT RAYS

heat radiation from this portion of arch on the fresh fuel also becomes much reduced. This is of great disadvantage, as we need high temperatures for drying and igniting the freshly charged fuel. For this reason it is found advisable to design the brickwork in such a manner as to bring a great quantity of heat from the end of intense combustion to that of the fresh fuel.

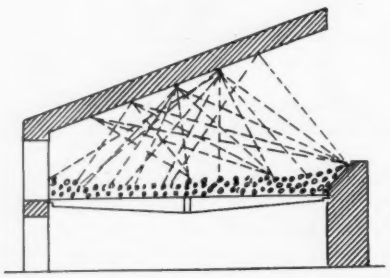


FIG. 6. REFLECTION OF HEAT RAYS BY FLAT TYPE OF ARCH

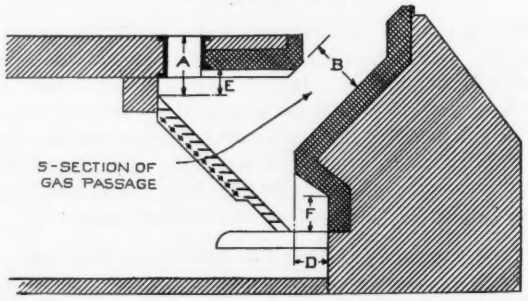
Such an arrangement of brickwork may employ one of two distinct principles.

1. The design of arches for concentration of heat by reflection,
2. The design of elbows for concentration of heat by deflection.

Considering the arch, this is based on the principle of heat rays acting in the same way as the rays of light on a mirror, where the angle of incidence is equal to the angle of reflection. Sufficient effect for fuel of low moisture content is generally obtainable with horizontal and slightly inclined arches. The effect of such arches depends on their shape which is either circular or flat. The circular type is of importance where strong concentration of heat on a single point is required, while the flat gives a more uniform distribution of heat and therefore is not as effective. The complicated design and construction of circular arches makes many engineers use the flat type, but primary cost is not always a matter of most importance. Considering the design of circular arches, we have to be sure that the fresh fuel will be covered by the reflecting rays.

Referring to Fig. 5, we have all rays from the rear end concentrated on a single point as O. Now should the circle passed by the arc of the arch be smaller, the point O would begin to descend; and as the portion A B covered by the reflected heat rays depends on the position of point O, the arch therefore may be adjusted in a manner to fulfill the necessary requirements. The limiting of area for the heat rays to affect the fuel gives a more efficient drying and ignition as compared with flat type of arch that distributes the rays more widely. The reflector of the rays by the flat type of arch shown in Fig. 6 is governed by the inclination and height of the arch. The less inclined and the lower the arch is installed, the less the radiation of heat that affects the fresh fuel lying on the front of the bed. Some inclination is therefore absolutely necessary in order to increase the effect of the arch, while it is important to hold this within limits in order not to enlarge the combustion chamber too much. Both of

TABLE OF DIMENSIONS OF BOILER FURNACE BURNING FUELS WITH HIGH MOISTURE CONTENT



Heating Surface of Boiler	Grate Area	Proportion of Grate to Heating Surface	Length of Grate In.	Width of Grate In.	In. clination Deg.	A	B	D	E	F	Section of gas Passage
204	2.270	1/90	57	52.8	45	41.3	19.7	71	15	19.5	8.07
204	3.680	1/56	84.5	67.	52	48	31.5	14.2	21.7	24.8	17.2
204	2.870	1/71	124	51.2	45	63	31.5	19.7	36.7	14.2	14.6

these arches are, however, insufficiently effective for fuels of moisture content greater than 40 per cent, because it will take too long for evaporating this moisture before the igniting effect would start, and therefore elbows acting on the principle of deflecting heat come into important use.

Considering such a deflection of heat, this is generally obtained by providing elbow A, Fig. 7, above the small horizontal grate N. In this case, the fire under the elbow is directed on the upper portion of the grate tending to heat and ignite the green fuel.

The design of these elbows generally depends on the following three things:

1. The angle; 2. The height from the fuel bed; 3. The distance of the projection. Considering the angle

X to be used with the elbow, this is usually very large and even much larger than that supposed to be suitable from the theoretical point of view. The reasons are two-fold: First, the portion of the grate covered by the fire depends directly on the angle and therefore should the angle X be small, it will affect the lower portion of the grate and not the upper, but as well understood, we want the fire to cover the upper portion of the grate where the green fuel enters; second, it is practically found that the preferable angle is that equal to the inclination of the grate, so that the inclined grate and elbow would be parallel to each other. This angle is generally 45 deg. The height of the elbow from the grate is the most troublesome question, due to the unknown thickness of fuel bed. As moist fuels are usually light in weight and as light fuels tend to slide from the inclined to the small horizontal grate N, the thickness of the fuel bed varies greatly.

Considering the flame, we know it to be lower in temperature near the fuel bed and higher near the end of the flame, and therefore the intensity of the heat that affects the green fuel through the use of the elbow will depend upon the condition of flame at the point of refraction. Should the fuel bed become thicker, the low temperature flame will be deflected and the effect

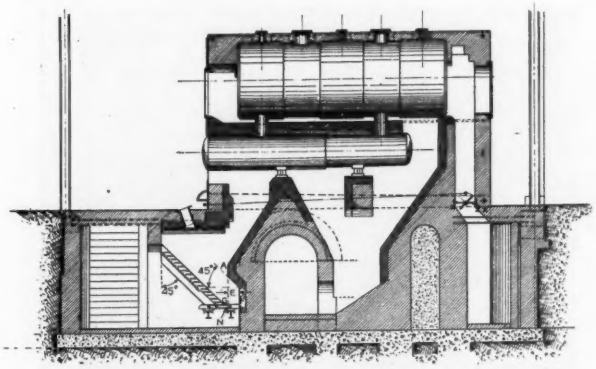


FIG. 7. FURNACE DESIGNED FOR BURNING FUELS CONTAINING A HIGH PERCENTAGE OF MOISTURE

will be small. Therefore this height is quite difficult to determine with such installations, but as to present day practice we can refer to the table of dimensions.

In regard to the projection distance E, Fig. 7, it is necessary to take into account that the quantity of burning gas deflected by the elbow is absolutely dependent on it; the greater the projection the greater the quantity of heat deflected by the elbow. From the practical point of view, the required effect decreases very much by the decrease in the distance E, i. e., the design, Fig. 2, will affect very little the fuel on the grate or the fire will easily take its path to the boiler shell without even being deflected. Another practical item is that when projections are made they should not be pointed as shown in Fig. 2, as the clinker adheres to them so strongly that this point of brickwork is mostly broken off at cleaning.

WORK is being done at Pittsburgh, Pa., by the United States Bureau of Mines, on a portable method for determining the dissolved gases in boiler feed water, especially hydrogen. Some boiler feed waters have been found to contain more than 30 per cent hydrogen.

Gas to Be Used for Industrial and Domestic Heating in Denver

HENRY L. DOHERTY, president of the Denver Gas and Electric Co., true to the advance information he gave, has started a gas-drive to make Denver, Colo., the first smokeless city of the world. Should the venture be successful in Colorado, it will be tried at other places, hence it is that all eyes are riveted on Doherty and his pet scheme—a scheme that he has been nursing for years. In a few words, here it is:

The gas rate that was available for industrial purposes cost $1 per 1000 cu. ft. with a discount for prompt payment, but now the following industrial gas rates will apply to gas for house heating and industrial use.

1—A customer charge per annum....	$9.00
Payable in 12 equal installments of 75c per month, less 10 per cent discount for prompt payment.	
2—A demand charge per 100 cu. ft of maximum hourly demand per annum	$30.00
Payable in 12 equal installments of for prompt payment.	
$2.50 per month, less 10 per cent	
3—A consumption charge: For the first 15,000 cu. ft. of gas metered per month, per 1000 cu. ft.....	$0.63 net
For the next 85,000 cu. ft. of gas metered per month, per 1000 cu. ft.	$0.40½ net
For the excess above 100,000 cu. ft. metered per month, per 1000 cu. ft.	$0.31½ net

The suggestion is made to all concerned to make application to the gas company for any help on their problems and the engineers will make it plain whether or not it is more economical to use the gas in preference to oil or coal.

Earnestness

WHATEVER YOU try to do in life, try with all your heart to do well; whatever you devote yourself to, devote yourself completely; in even the smallest as well as in the greatest undertakings, be thoroughly in earnest.

Never believe it possible that any natural or improved ability will gain in the end, unless associated with the qualities of steady, plain, hard work.

Sometimes talent and fortunate opportunity form the two sides of the ladder on which men mount, but the rungs of the ladder must be made of stuff to stand wear-and-tear, and for this there is no substitute for thoroughgoing, ardent, and sincere earnestness.

Never put your hand to anything into which you cannot throw yourself, body, soul, and mind; and having chosen your work to do, never affect depreciation of it.—Parrottalks.

ABOUT 100,000 T. of coal a year were required to operate the St. Gothard Railroad from Lucerne to the Swiss-Italian frontier, but now the entire freight and passenger traffic is handled by hydroelectric power.

Formation of Slag on Boiler Tubes

CONCLUSIONS ARRIVED AT AFTER EXTENSIVE TESTS OF COALS FOR SLAG FORMING PROPERTIES; BOILER OPERATION AND METHODS OF PREVENTING THE FORMATION OF SLAG ON BOILER TUBES. BY HARRY H. BATES*

RECENT boiler and stoker development is toward the extremely large units, which are operated at capacities far beyond those that were considered normal a few years ago. The fact is that it is a daily occurrence to hear of boiler stations operating at 300 per cent of rating or more, and it is by no means unusual that 400 per cent of the rated capacity and more are reached.

These large boiler and stoker units with their large grate areas and high gas velocities caused by high capacities, have brought about problems that have reached considerable magnitude in the combustion field of engineering. Most of these problems have existed ever since coal has been used for fuel purposes for steam generation; but until quite recently the small, easily accessible units used did not serve to indicate the extent of the trouble that would be involved. With the introduction of the large units, it has become necessary to study these problems and experiment in furnace construction in order to eliminate, as far as possible, the difficulties encountered.

One of the most serious, as well as most baffling, of these problems is the formation of slag on boiler tubes. That this is a problem that can become serious is shown in Fig. 1, and it is to be stated that the slag shown was deposited in less than one week of operation, in spite of all the care and work done in attempting to remove it.

To determine the exact means by which the material is deposited and the chemical reactions that actually take place is a very difficult task; but, after 6 mo. investigation of the subject, certain deductions were arrived at. During the entire investigation, it was constantly borne in mind that effectively to overcome the slag problem it would first be necessary to establish the cause of its formation, how it is carried up to the tubes, and the form in which it is deposited.

SIMILARITY OF CAUSES OF CLINKER AND SLAG

IN DISCUSSING the problem of slag formation on boiler tubes, it is well that a brief discussion be given on the formation of clinkers in the furnace itself. The slag found on the boiler tubes and furnace walls is of the same material as the clinker that is discharged from the furnace, and the causes of one are to a large extent the causes of the other.

The principal constituents of ash are silicon dioxide (SiO_2), aluminum oxide (Al_2O_3), ferrous oxide (FeO), ferric oxide (Fe_2O_3) and lime (CaO). There are other materials present, but they are in such small quantities that their presence and effect are practically negligible and will not be discussed in this paper. Table I shows the atomic weights of the principal constituents of ash as well as their fusing temperatures.

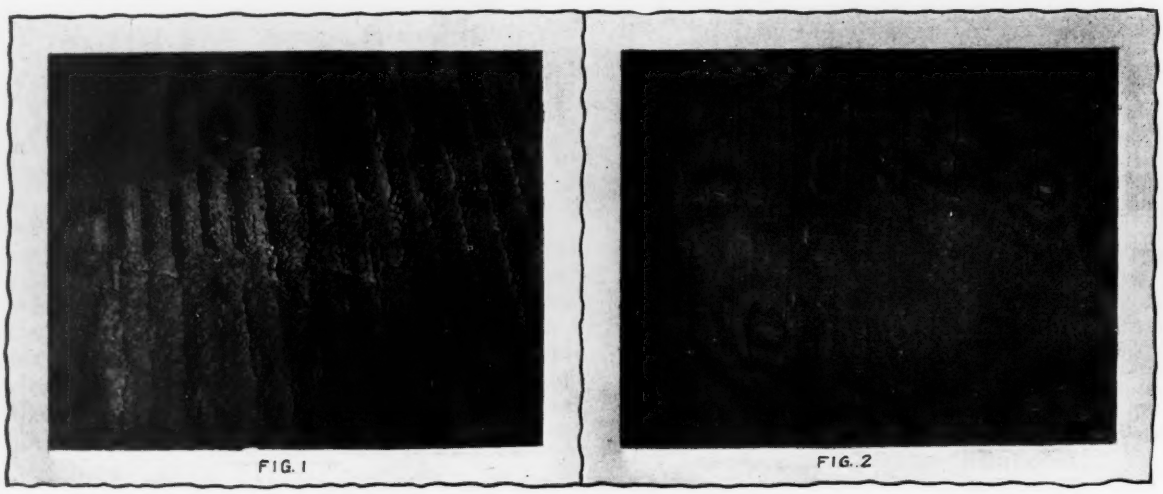


FIG. 1. PHOTOGRAPH TAKEN AFTER RUN DESCRIBED IN TABLE III. SLAG WAS ALLOWED TO FORM FOR OBSERVATION PURPOSES UNTIL THE BOILER WAS INOPERATIVE

FIG. 2. ACTION OF SLAG ON BOILER WALLS AND TUBES. WALLS HAVE SMOOTH, GLAZED FINISH WHERE FUSED SLAG RAN DOWN. ERODED PLACES IN WALL ARE WHERE THE CAST-IRON HANGERS FORMERLY SUPPORTED THE SOOT BLOWER ELEMENTS. THESE HANGERS MELTED AND RAN DOWN WALL

TABLE I. PRINCIPAL CONSTITUENTS OF ASH AND THEIR FUSING TEMPERATURES

Oxide	Formula	Atomic Wts.	Fusing Temps. Deg. F.
Silicon Dioxide	SiO_2	60.30	3227
Aluminum Oxide	Al_2O_3	102.20	3416
Ferrous Oxide	FeO	71.84	2586
Ferric Oxide	Fe_2O_3	159.68	2840
Lime	CaO	56.07	3452

Table I is of particular interest because, with the one exception of ferrous oxide, there is not one of the principal oxides of which the ash is composed that

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will fuse at ordinary furnace temperatures alone. It is when these oxides are heated in intimate contact with each other that the real clinker forming properties present themselves. The basic oxides act as fluxes on the silica present with a lowering of the fusing temperatures of the combined material. The fusing temperature is dependent upon the oxides that are brought in contact with the silica and the proportion of each. These basic oxides, together with the silica, form monosilicates of the general form of $CaO(SiO_2)$ etc. These monosilicates have a much lower fusing temperature than the oxides of which they are composed. As an example of this fluxing action; pure silica fuses at 3227 deg. F., pure ferrous oxide fuses at 2586 deg. F., but ferrous silicate fuses at 2318 deg. F. If lime is added to this silicate in various proportions the fusing temperature may be anything down to 2066 deg. F. From the above it may be said that ferrous silicate alone, or in combination with lime up to about 40 per cent of the total ash, will give a fusing temperature well below ordinary furnace temperatures.

Tests made by the United States Geological Survey indicate that the tendency of ash to clinker is increased as the per cent of iron increases, but this may not be true invariably.

TABLE II. SULPHUR FORMS IN COALS

Sulphur Form	Upper Freeport, Pa.	Pittsburgh, Pa.	Pocahontas, W. Va.	Elkhorn, Ky.	Coal Creek, Tenn.	Cherokee, Kan.
Pyritic Sulphur	0.47	0.79	0.08	0.13	1.75	1.99
Sulphate Sulphur	0.07	0.23	0.01	0.04	0.71	0.32
Organic Sulphur	0.62	0.66	0.46	0.51	1.78	0.71
Total Sulphur	1.16	1.68	0.55	0.68	4.24	3.02
Per cent of Pyrites in Total Sulphur	40.5	47.0	14.5	19.1	41.3	66.0

It will be noted that the pyritic sulphur comprises from 40 to 60 per cent of the total sulphur, except in the Pocahontas and Elkhorn coals, and these coals are generally considered high grade steaming coals and give a minimum of clinker trouble. If sulphur accompanies the mixture it retains its form as ferrous sulphide and this material, in conjunction with silicious matter, makes an even more easily fusible mass than those already given.

Formation of Slag on Boiler Tubes

The foregoing discussion of clinker formations also applies almost in its entirety to slag formations on boiler tubes and walls. The condition is suggested that the iron must be kept in its ferric state which is practically infusible. This can only be done by completely oxidizing the sulphur and iron before the tubes

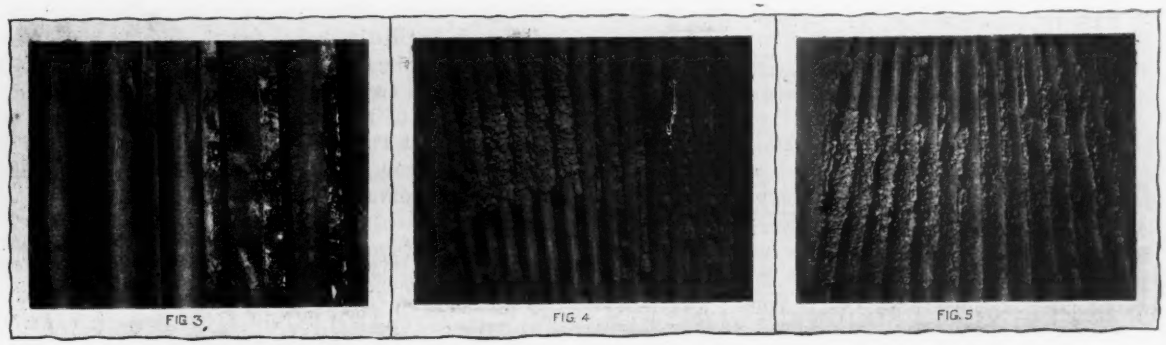


FIG. 3. CLEAN BOILER TUBES. THREE TUBES ON THE LEFT HAVE BEEN SCRAPED. TWO TUBES AT THEIR RIGHT HAVE HAD THE SLAG KNOCKED OFF, BUT THE TUBES WERE NOT SCRAPED

FIG. 4. ILLUSTRATING HOW THE SLAG FORMS ON THE SECOND ROW OF TUBES AND BLOCKS THE GAS PASSAGE BETWEEN THE FIRST AND SECOND ROWS, AS EXPLAINED IN THE TEXT AND AS SHOWN IN FIG. 7

FIG. 5. ACTION OF SLAG ON THE BOILER WALLS AND TUBES. TAKEN AT A DIFFERENT TIME FROM FIG. 1 AND SHOWS THAT THE SLAG FORMS IN THE SAME WAY IN EACH INSTANCE

Iron combines with silica in the form of ferrous or ferric oxides, but not in the form of suphides; however, it is only a matter of supplying heat and oxygen to convert the iron into its ferric state.

The per cent of sulphur found in an ultimate analysis of coal is frequently blamed for the excessive formation of clinkers, but sulphur is not a slag forming material in itself. It is usually found in the fuel as sulphates or pyrites which is ferric sulphide. The sulphates are not troublesome to a great degree, but the larger portion is in the form of pyrites and it is the iron in this combination that really is the disturbing factor.

The United States Bureau of Mines has made an extensive research of the sulphur forms in coals. Table II gives the relative proportions of the several forms, as obtained from their Technical Paper No. 254, by A. R. Powell.

are reached. No free oxygen passes through a well broken up fire (United States Bureau of Mines, Technical Paper 139, and Bulletin 135). Unless excess air is added over the fire an incomplete combustion of carbonaceous matter and other oxidizable substances results. For this reason, it can be considered with reasonable surety that complete oxidation of all slag forming constituents can not be accomplished within the limits of the fuel bed proper. The inherent characteristic of the underfeed type of stoker to burn fuel more rapidly over the tuyere rows than over the retorts aids materially in supplying the required distribution of oxygen for the complete oxidation of all oxidizable matter, but, even with this type of stoker, slag formations on the tubes and furnace walls are a serious problem with some coals.

It can here be said that all types of stokers; underfeed, overfeed and chain grates, have difficulty with

slag formations. Even a low velocity gas from a quiet fire on a natural draft stoker will carry quantities of this slag with it and deposit it on the tubes and walls.

These facts, especially those concerning the slag being carried to the tubes at all boiler ratings and gas velocities, suggest that the slag particles are carried up with the draft in such minute form that they can be carried with the low velocity gas as well as the gas that rises rapidly. An examination of the slag under a microscope revealed small spherical globules which substantiated the belief that the particularly troublesome particles were the small ones.

When these little particles come in contact with the free oxygen in the furnace gas for a sufficient time to oxidize them completely, they will be transformed into their completely oxidized state and become solid. If they solidify before touching the tubes or walls, they are carried through the boiler as solid ash. On the other hand, it has already been pointed out that no free oxygen is obtained through the fuel bed. In this event, the particles remain in a molten condition, on account of their low fusing temperature in their -ous state, and are deposited on the tubes and walls where they may either be completely oxidized and solidified or be cov-

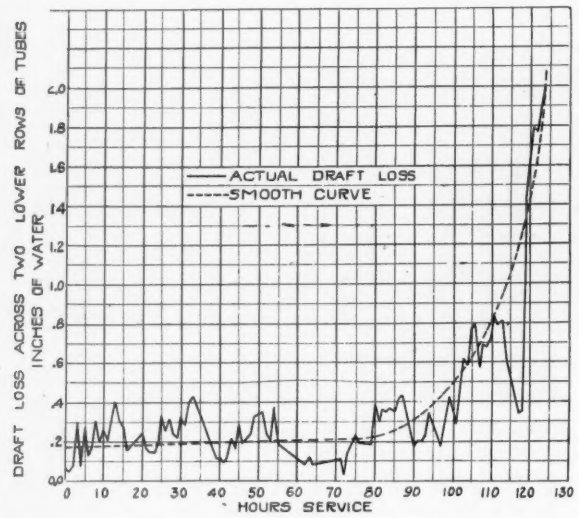


FIG. 6. RATE WITH WHICH SLAG FORMED ON TUBES WHEN BOILER WAS OPERATED AT 320 PER CENT (AVERAGE) RATING

ered by successive coatings or layers of the same plastic material.

That the latter is true to a large extent, is shown by layers of a very dark vitreous material covered by a reddish brown layer or protective coating. This reddish coating is largely ferric material and it prevents further oxidation of the dark ferrous material within by excluding the oxygen from it. A considerable portion of the material on the outer surface, especially on the tubes, is of a friable and non-fusible character, and it is of a completely oxidized nature.

Admitting Excess Air to Furnace Gases

Manufacturers of stokers and stoker auxiliary equipment have produced equipment for supplying excess air over the fire in order completely to burn combustible gases. They have undoubtedly accomplished some beneficial results, but even now, there is yet considerable research and experimental work to be done on the extra large, super-power station type of boilers. The extreme size of these furnaces makes correct distribution of air to the furnace an extremely difficult problem to solve. The nearest approach to a suitable device so far developed is an installation with perforated cast-iron air distributing boxes above the throat of the stoker.

Another type of equipment frequently used for this same purpose, is the ventilated wall of perforated fire brick. This method is satisfactory for the ordinary size of furnace, but for the larger units a very strong jet action is required to force the air to penetrate the rapidly rising volume of gas to a distance sufficient to oxidize the particles in the center of the gas passage. These devices serve well for protecting the boiler walls, but can not be considered as suitable for slag prevention in large furnaces.

Even if some efficient means is developed for mixing the gas and excess air together, it is very questionable whether the slag difficulty will be entirely overcome. It is to be remembered that in addition the problem of supplying and mixing the oxygen and combustible gases time is required for the various chemical reactions to take place.

There is but little chance for thoroughly mixing all gases in the combustion chamber, as the rapid rate with which the gases ascend prevent a thorough mixing and a stratification of the gases result. An illustration of this is shown in Table III. These figures are values of CO_2 from gas samples taken under every second tube, and at 2-ft. intervals along the tubes.

TABLE III. ANAYLSES OF SAMPLES TAKEN FROM FIRST PASS BAFFLE OPENING IMMEDIATELY UNDER THE FIRST ROW OF TUBES VERTICAL BAFFLE

Tube No.	41	37	31	27	23	19	15	11	7	3
CO_2	10.6	11.0	11.4	15.0	15.3	16.2	13.0	12.4	13.4	10.5
	10.1	12.0	14.0	16.0	17.5	13.4	13.0	12.8	12.8	13.0
	10.0	12.8	15.5	16.5	17.8	13.0	14.5	13.7	10.2	13.7
	11.9	10.5	14.9	15.7	17.9	14.3	14.0	14.3	13.4	10.6

Front Wall

These readings showed a carbon dioxide content of from 10.0 per cent along the walls to 17.5 per cent in the center. From these figures, it can be appreciated that the chances for the ferrous material to change into the ferric state are very few. It was evident that there was an insufficient penetrative effect from the ventilated walls to take care of the wide furnace, and also it is noted that there was considerable excess air along the walls.

Composition of the Slag

Numerous samples of coal, ash, and slag were analyzed, the last of which are particularly interesting because they corroborate the above conclusions. Table IV gives a typical analysis of the slag taken from both the boiler tubes and the furnace walls.

TABLE IV. TYPICAL ANALYSES OF SLAG SAMPLE TAKEN FROM FURNACE WALLS

Ferrous Iron	8.26 per cent
Ferrous Iron calculated to Ferric Iron	9.18 per cent
Ferric Iron, found as such	6.71 per cent
Total Iron	15.89 per cent
Ratio of Ferrous Iron to Total Iron	57.7 per cent

SAMPLE OF SLAG TAKEN FROM BOILER TUBES

Ferrous Iron	3.23 per cent
Ferrous Iron, calculated to Ferric Iron	3.58 per cent
Ferric Iron, found as such	8.71 per cent
Total Iron	12.29 per cent
Ratio of Ferrous Iron to Total Iron	29.1 per cent

It is interesting to note that the slag on the furnace walls ran much higher in ferrous iron, by per cent, than did the slag on the tubes. In consequence of this the slag on the walls was much freer from the coarse, friable, infusible material than was the material on the tubes. The hard vitreous appearance of the slag on the walls gave evidence of having been there in a molten and flowing condition until such time as the furnace was cooled below the fusing temperature of the mass. The smooth appearance of the wall shown on Fig. 2 as compared with the rough material on the tubes, shown on Fig. 1, further verifies this point.

Numerous theories were advanced during this investigation as to the causes of slag formation on the tubes. Chief among these was the condensation of tarry vapors on the tubes to which the flying particles could adhere and solidify. It is true that the coal contained a high percentage of volatile matter and was rich in tars, but that this had a material effect in the formation of the slag is highly improbable. If tarry vapors existed in the ascending gases and actually condensed on the tubes any coating on the tubes would be extremely thin. Tars are fairly good heat insulators and only a thin coating of tar would form before it would begin to burn away when subjected to the furnace temperature, which at times was 2800 to 3000 deg. F.

Even if the lack of temperature permitted the film of tar to form on the clean external surface of the tubes, the insulating effect of a thin layer of slag would prevent further condensation of tar. That this did occur was borne out by the fact that only about $\frac{1}{16}$ to $\frac{1}{8}$ in. of the slag on the tubes remained there in a completely frozen state. The melting point of the slag was 2138 deg. F., which is much above the vaporizing temperatures of any tars in the fuel and, consequently, a condensation of these tars would be impossible.

As commonly found in furnaces of all kinds, a considerable amount of visible solid particles were carried up with the rising gases. On the clean tubes these did not appear to have any effect, as they simply struck the tubes and rebounded, sometimes falling back in the furnace, or were carried through the boiler with the gases. Figure 6 is interesting in that it shows how rapidly the draft loss increased across the two lower rows of tubes, after an adhesive coating of molten slag had formed on the under sides of the tubes. After this coating had formed, a great portion of the solid particles struck and adhered to the plastic material and the rapidity with which the slag formed was greatly increased, both by this and the rapidly growing area presented for contact.

On the large number of tests made, it was indicated that the slag deposit on the tubes was nearly proportional to the total amount of gas, and was not greatly affected by the rating. The amount of slag was affected by temperatures in the furnace, however, for the hotter fires kept the slag in a more viscous state which greatly increased the tendency for cinders and particles of ash to adhere.

Experiments Made to Prevent Slag Accumulation

As previously stated, the slag problem is a chemical problem, and the desirable remedy would be a chemical remedy, providing the cost of maintaining chemical action is not excessive. Such action may be set up in three different ways:

1. By feeding some material in with the coal that will act as an oxidizing agent.
2. By feeding some vapor in with the air supply, which will dissociate and permit its oxygen to combine with the ferrous material present.
3. By intimately mixing air, at high temperature, with the rising particles, so as completely to oxidize them before reaching the tubes.

By analysis of these three courses for experiments the first one was eliminated without trial. It was not considered feasible to feed any solid oxidizing substance in with the coal. The first cost would certainly be prohibitive, besides a greater amount of ash would have to be handled.

The second procedure was tried out by the injection of steam into the air supply. No decrease was noticed in the formation of slag on the tubes.

It is to be remembered that at no place in the fuel bed, except on the dumps, could the ash have been over 50 per cent of the total fuel bed. Further, the ferrous material was not over 10 per cent of the ash. It is, therefore, apparent that the ferrous material, representing a maximum of 5 per cent of the total fuel bed, had but little chance of coming in contact with the liberated oxygen and solidifying in its ferric state.

In reality, this was expected as it was deemed impracticable to put enough water through the fuel bed to insure complete oxidization of the ferrous material with all the other combustible matter present.

More recent experiments have shown that the introduction of water vapor into ash and refuse undoubtedly prevents a spongy mass of clinker from adhering together. This, however, is a vastly different proposition from the former as it is necessary only to oxidize the surface to prevent adhesion where about 80 per cent of the material present is incombustible.

The third method suggested, namely, by intimately mixing air with the gases, is now being tried. The original boilers were set about 13 ft. from the grates. It was thought that, by increasing the distance between the grates and boiler tubes, the gases would have more opportunity to mix thoroughly. Also, since the total time of travel of the furnace gas is dependent upon the velocity and distance of gas travel, more time would be allowed for complete oxidation of the small particles. Consequently a boiler was set up 6 ft. higher than those originally installed.

Assuming that the rapidity with which the gas rises from the fuel bed is uniform, it is calculated that its velocity was about 18 ft. per second. This is the lowest possible velocity that can be expected. The direction of

gas travel is from the grate direct to the baffle opening, which was proportioned as 46 per cent of the grate surface. Necessarily the velocity was twice as high under the baffle as it was leaving the fuel bed.

On this basis, the time it took for particles to reach the tubes with the original installation would be 0.72 sec. This is very little time for oxidization to take place, unless it is of an explosive character. Further, by raising the boiler to 19 ft., this same time would be 1.05 sec., which is still of very short duration.

This arrangement has not shown any great improvement in slag prevention and has the disadvantage of exposing more brickwork to high temperatures and to draft, with resulting greater infiltration of air through the setting.

Furnace construction undoubtedly has much to do with the external encrustation of the tubes with slag. The ratio of the exposed tube surface to the grate area was 1 to 1. This is very low and the lower the ratio, under set conditions of fuel and fuel bed, the higher will be the furnace temperature. It is apparent that the higher the furnace temperature the greater will be the tendency for the ash to fuse and stick.

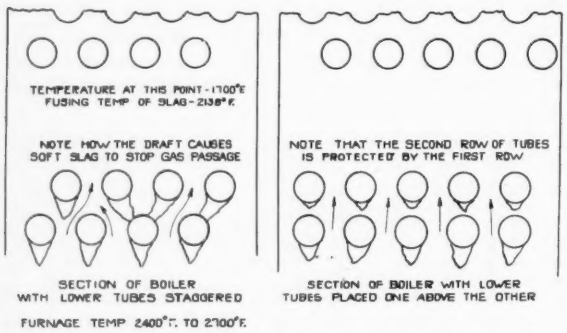

TEMPERATURE AT THIS POINT - 1700°F
FUSING TEMP OF SLAG - 2138°F.
NOTE HOW THE DRAFT CAUSES SOFT SLAG TO STOP GAS PASSAGE
SECTION OF BOILER WITH LOWER TUBES STAGGERED
NOTE THAT THE SECOND ROW OF TUBES IS PROTECTED BY THE FIRST ROW
SECTION OF BOILER WITH LOWER TUBES PLACED ONE ABOVE THE OTHER
FURNACE TEMP 2400°F. TO 2700°F.

FIG. 7. WAY IN WHICH SLAG FORMS ON BOILER TUBES

It has become common practice now to have the ratio of exposed tube surface to grate surface as high as 1.87 to 1, and is seldom less than 1.2 to 1. By increasing this ratio the amount of heat radiated up and absorbed is very materially increased with a consequent reduction in furnace temperature.

This last item, namely furnace construction, is a step in the right direction. Unfortunately, the construction of the investigated installation did not permit changing the ratio (1 to 1), and, for comparative purposes, it was necessary to refer to a neighboring station with a similar type of stoker and boiler, which used a similar coal. This second plant has had practically no trouble with slag on tubes and uses only the soot blowers while the boilers are in operation.

An interesting difference in the two stations was that the first two rows of tubes in the former were staggered, and slag impinged on and stuck to both rows. The second row caused more trouble than the first row, as the slag took the form of icicles or stalactites and when they became long enough and the velocity of the gas become high enough, the "icicles" bent sideward until they touched the lower tubes. This effectively sealed the gas passages of that part of the boiler (see Fig. 7).

The second installation had the first two rows set one above the other. The material which struck the bottom row of tubes adhered, but the rapidity of the formation was far less. On account of this arrangement, the gases were sufficiently cooled by passing between these tubes to prevent the slag from sticking and there was no further tendency for the slag to adhere to the boiler surfaces.

When it is considered that the ash is finely divided in the coal, and that some of it is certain to be carried up with the gas, it appears that the most fruitful field for development of means for slag prevention is in furnace and boiler design. This belief has already been justified. At the same time there is still need for further development of apparatus for mechanically removing soot and slag from boiler tubes.

From the foregoing it is seen that the chemical composition and fusing temperatures of the ash were known, and a careful and complete record was obtained of all happenings in the furnace and around the boiler. With the aid of this information and the assistance of U. S. Bureau of Mines, evidence was obtained that has led to the above general conclusions.

Considerable value was received from this investigation, because much was learned of the effect of furnace, boiler and stoker construction on the slag problem.

It is extremely fortunate that only a comparatively few coals give slag trouble to a serious degree. A great many coals have fusing temperatures so high that they give no trouble with ordinary furnace temperatures. Another class of coals have low fusing temperatures, but do not seem to have the tendency to be lifted from the fuel bed. But when a coal gives serious slag trouble, with the present knowledge of the art of burning coal, means must be provided for its mechanical removal. This, however, is not as serious a matter as it appears, for soot blowing in boiler plants is now recognized as a necessity, and apparatus for soot removal is now installed as regular boiler equipment.

Safety Warnings

THESE CAN hardly be too conspicuous; but they are useless if the workers cannot read the local language—or even read at all.

It could do no harm if in every shop in this "polyglot boarding house" called America, danger signs in several languages were displayed prominently wherever appropriate. There may not be, say, a Hungarian or an Ukrainian employed in the shop when the signs are posted; but one may come, and "forewarned is forearmed;" the management will have done its duty in this respect at least, if the warnings are put up in all languages available. ROBERT GRIMSHAW.

THE ABILITY and resourcefulness of modern scientists is rather forcibly illustrated by the following. At a meeting of the Royal Institution, in London, England, Sir Ernest Rutherford made the statement, in a lecture on radio-activity, that there is at the present moment only one-tenth part of a cubic millimeter of that extraordinary gas called "radium emanation" available in the world. Notwithstanding this, the scientists have been able to determine its atomic weight, its density, its spectrum and its boiling point. Perhaps it may be permitted to suggest that that tenth of a cubic millimeter of gas must have felt somewhat fatigued when the scientists got through with it.

Operating Conditions Maintained at Dalmarnock Station

TEST RESULTS, HEAT BALANCE, AND OPERATING DATA OBTAINED IN NEW BRITISH POWER STATION. BY C. H. S. TUPHOLME

SOME interesting particulars of the new power station installed at Dalmarnock for supplying electricity to Glasgow city were recently given to the Institution of Electrical Engineers by R. B. Mitchell.

It is recognized that the boiler house provides the greatest scope for the working of economies, and so far as the original lay-out of the station permits everything possible has been done at Dalmarnock to help to attain high efficiency. The following figures will indicate the results which are being obtained at present. These figures are abstracted from the working logs of No. 1 boiler house; no attempt has been made to select a specially favorable example.

DATA AND HEAT BALANCE OF NO. 1 BOILER HOUSE (4 TO 7 UNITS IN OPERATION)

Average boiler pressure, 274 lb. sq. in. gage.
Total steam tem., 700 deg. F.
Tem. feed water, econ. inlet, 141 deg. F.
Average temp. feed water, econ. inlet, 141 deg. F.
Average temp. flue gases, econ. inlet, 630 deg. F.
Average temp. flue gases, econ. outlet, 400 deg. F.
Average percentage CO_2, 10 per cent.
Calorific value of coal, 10,800 B.t.u.
Air temperature, 70 deg. F.
Draft over fires (inches water), 0.3 in.
Draft at damper, 1.5 in.
Draft at fan (induced), 2.5 in.
Total coal consumed, 953,580 lb. or 425.7 long tons.
Ashes, 45.33 long tons.
Ashes, per cent of fuel consumed, 10.65 per cent.
Total water evaporated, 6,264,960 lb.
Condensate, 6,024,000 lb.
Make-up water, 240,960 lb.
Make-up water, per cent of total, 3.85 per cent.
Pounds of water evaporated per pound of coal, 6.5 lb. (actual).

Power consumption of auxiliaries as percentage of fuel consumed, 1.68 per cent.

From the foregoing information in the table, the heat balance is obtained as given in the next table:

HEAT BALANCE—NO. 1. BOILER HOUSE, DALMARNOCK

To calorific value of coal	10,800	
To power consumption of boiler house auxiliaries (B.t.u. equivl. per lb.)	181	100
Total	10,981	100
To heat transfer in boiler	6,253	56.94
To heat transfer in boiler, superheater	1,014	9.23
To heat transfer in boiler, economizer	864	7.86
To heat transfer in boiler, combined plant	8,131	74.03
To loss in flue gas	1,644	14.98
To loss in flue gas, radiation	549	5.00
To loss in flue gas, ashes, moisture and unaccounted for	657	5.99
Total	10,981	100.00

It is evident from an inspection of these figures that the chief source of loss is in the heat escaping in the flue gases. Provided that space is available and that a sufficiently large heat transfer apparatus can be built for a moderate capital outlay, there seems to be nothing to prevent the use of these hot flue gases to pre-heat the furnace air supply, and the gain will be represented in a more efficient heat balance and in a saving of coal per kilowatt-hour.

The lay-out of Nos. 1 and 2 boiler houses does not, unfortunately, lend itself to the installation of an apparatus of the foregoing description. In Nos. 3 and 4 boiler houses which are yet to be built, its possibilities will not be lost sight of. The installation of automatic coal weighing machines has made it possible to obtain accurate figures of the coal consumed during each shift, without any delay. It is then a simple matter to balance this figure against the station output for the same shift.

By plotting the results on a chart, a "Willans" line is obtained which is recognized as a standard to which the station engineers must aspire. At Dalmarnock these results are plotted daily, and the records have been of great benefit. This method of record keeping would not have been possible had it not been for the weighing machines weighing the fuel as it is burned.

In many modern stations it has not been thought necessary to install these machines; but without them or some equivalent, no quick or accurate method of obtaining efficiency figures over short periods is available.

Under modern boiler house conditions where the closest supervision of the burning of fuel is imperative, the author is of the opinion that money expended on these appliances is well spent. The guaranteed combined efficiency of boiler, superheater and economizer, is 80 per cent. It will be noticed from the foregoing table that the boiler house efficiency attained under normal working conditions is about 74 per cent. It is expected that under better circumstances this figure will be considerably improved.

The method or methods adopted for driving the auxiliary plant and of using the heat energy rejected is next in importance, if not equal, to the economics of the boiler house. At Dalmarnock this problem has been tackled in various ways; in fact, it may seem that too many complications have been introduced. These auxiliary arrangements have been severely criticized, but the diversity of auxiliary plant gives experience and data which could hardly be determined other than by trial.

All the rotary auxiliaries are electrically driven from:—

1. (a) Two house turbo-generators each of 500 kw. capacity exhausting into open-type heaters through which the condensate is pumped; (b) two house transformers taking power direct from the 20,000-v. bus bars; (c) Nos. 3, 4 and 5 sets have auxiliary low tension windings on the step-up transformers.

2. Nos. 2, 3, 4 and 5 turbines have steam led at low pressure to heaters through which the condensate

may be passed. Nos. 2 and 3 have surface heaters integral with the turbine, and Nos. 4 and 5 external open type heaters.

3. The steam ejectors on Nos. 2 and 5 turbines exhaust into open type heaters, and the steam-driven boiler feed pumps exhaust direct into the hot well tanks. Electrically driven boiler feed pumps are also installed.

It is too early yet to state definitely which system or combination of systems, is the most economical to use, but it will be agreed that the operating engineers have ample means at their disposal, for investigating the relative merits of the different combinations. It is

power to main unit power is one of the advantages of large units over small ones. It has been said by a critic, and it will be agreed that "valuable lessons may be learned from the results observed in the operation of the Dalmarnock station, particularly in the matter of heat balance control and the auxiliary drive. The very complexity of the design makes for exceptional flexibility in operation and affords a rare opportunity to test out the different combinations under actual operating conditions."

All auxiliary motors are of the induction type, and their reliability has been extremely satisfactory. The

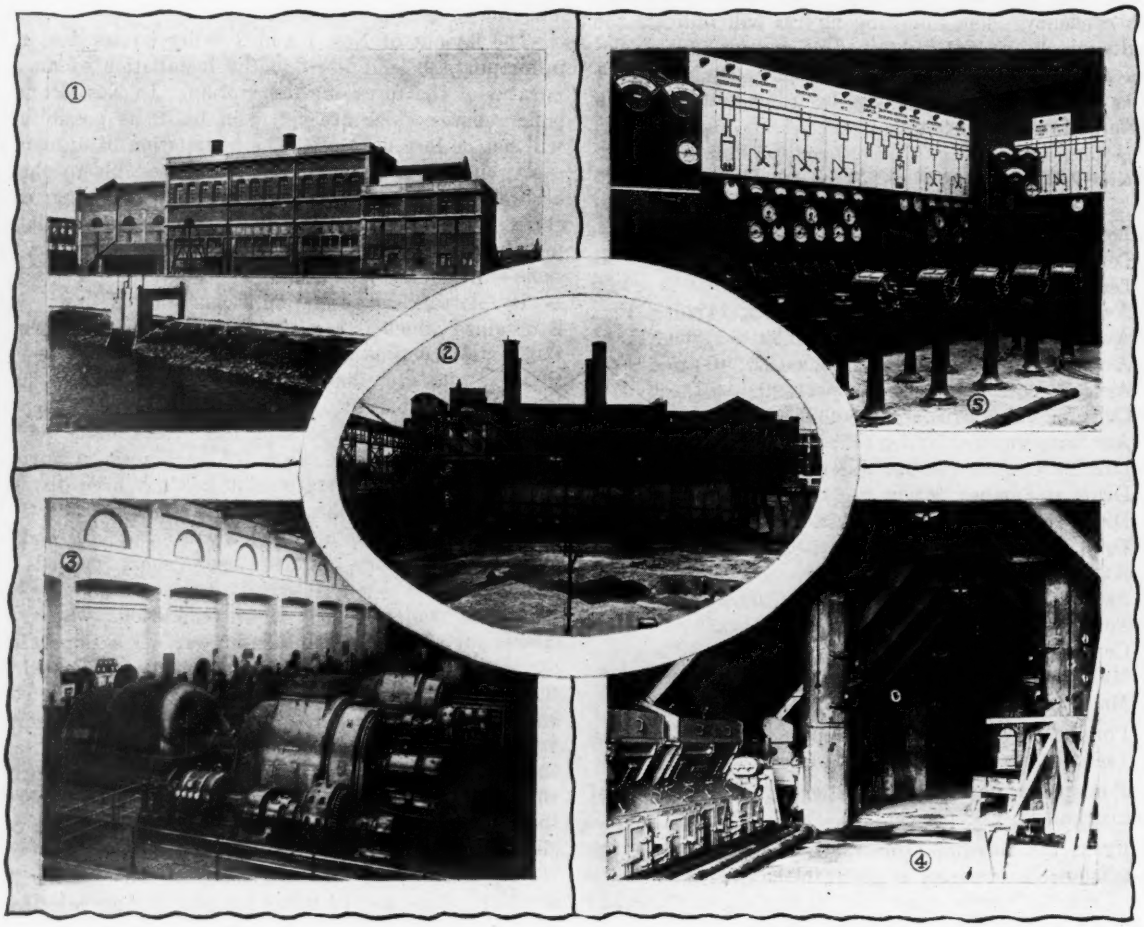


FIG. 1. DALMARNOCK STATION ON BANK OF RIVER SUPPLYING CONDENSING WATER. FIG. 2. COAL STORAGE YARD AT DALMARNOCK. FIG. 3. GENERAL VIEW IN TURBINE ROOM. FIG. 4. FIRING AISLE IN NO. 1 BOILER ROOM. FIG. 5. DIAGRAM OF CIRCUIT PROMINENT FEATURE OF CONTROL ROOM

certain that the integral heaters introduced in Nos. 2 and 3 sets add in a marked degree to the overall efficiency of the units, and there is much to be said for the regular use of the house turbines.

The ideal to be aimed at, however, is to have sufficient flexibility in the use of exhaust steam to be able at any time to use just the exact quantity required and no more. In the past, where steam-driven auxiliaries have been used without alternative, the amount of exhaust steam produced has been far in excess of requirements.

This, of course, depends on the size of the unit installed and the comparatively low ratio of auxiliary

economic aspect is by no means so clear, and investigations are being carried out to see whether too great a price is not being paid for the obvious advantage of simplicity of alternating current motors.

Every effort has been made to measure as accurately as possible all important quantities, and for this purpose each circuit in the station has been treated separately. The quantity of coal going to the furnaces is measured accurately by automatic weighing machines, as already stated, and is, in addition, indicated approximately on each furnace. The total quantity of air for combustion is indicated, and the temperature of the outgoing air is measured accurately, so that these quan-

tities give the chimney losses at any instant. The degree of combustion is measured by indicating CO_2 meters, one of which is placed on each furnace. The pressure of air at various points in the furnace circuit is measured by draft gages.

For the steam circuit, the usual equipment of pressure and temperature indicators for the live and exhaust steam, together with steam flow meters, provides an indication of the boiler output, which is almost as reliable and accurate as the electrical equipment for the output of the generators. This equipment provides the staff with means for practically continuous oversight of the boiler performance.

The performance of the turbo-alternator is also under continuous observation, the steam consumption being measured by a Lea recorder in the condensate circuit, while the output of the machine is measured by accurate watt-hour meters. It is interesting to note that no difficulty has been experienced in getting consistent results well within 0.1 per cent on the electrical end, although, of course, the question of the absolute accuracy of the results is much more doubtful. For accurate tests on the turbines, two steel test tanks, each of 28,000 lb. capacity have been installed permanently close to the turbine room, so that very accurate measurement of the steam consumption of any set can be made when required.

The whole testing equipment has proved extremely convenient in practice. The general idea underlying the arrangement of all testing equipment has been to take the pressure, flow, and resistance, as in an ordinary electrical circuit. To illustrate the performance of the various units in the station, tabulated tests are given. These include, boiler, turbine, and auxiliary plant tests. It is interesting to note how the various instruments have gradually gained the confidence of the operators. The steam flow meter, which was looked on in the early stages as a toy, is now considered to be absolutely essential, and the temperature measurements are now quite as reliable and accurate as the pressure measurements. Visitors should be able to check roughly the performance of any of the important parts of the plant while passing through.

Owing to the prevailing depression and the lockout in the engineering trades, the effect of which is still felt, the station output during the past few months has been much below what was expected. Dalmarnock has been carrying the whole load of the system and operating at a load factor of about 34 per cent. On an output for the last month for which figures are available the generating costs were as follows:

TABLE OF GENERATING COSTS

Comparison Costs for April, 1922

Operation	Pence per unit delivered: Average for year	Preceding month	April 1922
Coal	0.1825	0.1707	0.1752
Coal handling	0.0063	0.0065	0.0060
Ash handling	0.0080	0.0084	0.0082
Water	0.0009	0.0008	0.0009
Oil and stores	0.0037	0.0044	0.0040
Shift wages and salaries	0.0172	0.0169	0.0202
Maintenance and Repairs			
Buildings, wages	0.0045	0.0046	0.0057
" material	0.0008	0.0007	0.0007
Engine room, wages	0.0070	0.0070	0.0082
" " material	0.0040	0.0054	0.0061
Boiler room, wages	0.0113	0.0114	0.0132
" " material	0.0044	0.0043	0.0056
Oncost charges	0.0078	0.0080	0.0095
Totals	0.2584	0.2491	0.2635
Totals (less coal)	0.0759	0.0784	0.0883

Units	
Generated	10,764,200
Delivered	10,233,203
Coal Consumed	
Tons	9,056
Lb. per unit delivered	1.98
B.t.u. per unit delivered	20,679
Ashes Removed	
Tons (long)	1,210
Per cent to coal	13.36
Make-up Water	
Gallons (British) per unit delivered	0.046

DAILY RUNNING STATISTICS FOR WEEK ENDING MAY 10, 1922, IN DALMARNOCK STATION

	Standards	Thursday		Friday		Saturday		Monday		Tuesday		Wednesday	
Back Press--"Hg.	0.9	1.23	+33	1.36	+0.46	1.23	+0.33	1.51	+0.61	1.4	+0.5	1.39	+0.49
Theo.-Act.Vacuum--"Hg.	0.55	0.42	-13	0.63	+0.08	0.57	+0.02	0.78	+0.23	0.65	+0.1	0.61	+0.06
$\frac{W}{Tr.} = \frac{11.7}{11.2}$	1.04	1.18	-	1.20	-	1.34	-	1.31	-	1.56	-	1.31	-
Engine room steam effcy. $\frac{3410 \times 100}{(H-h) \times lb. \text{ per unit}}$	24%	22.25	-1.75	22.28	-1.72	21.95	-2.05	21.33	-2.67	22.3	-1.7	22.26	-1.74
Stack Temp. deg. F.	400	395	-5	378	-22	382	-18	392	-8	395	-5	389	-11
Percent CO_2	10.6	12.7	+2.1.	11.6	+1.0	11.1	+0.5	12.5	+1.9	11.8	+1.2	13.3	+2.7
Boiler Kennedy Factor													
Water evap. 50,000 x hr.	90.11	79.24	-10.87	76.26	+13.85	76.34	-13.77	76.82	-13.29	78.48	-11.63	79.27	-10.84
Boiler house effcy.	77.77	80.45	+2.69	76.39	-1.38	76.98	-0.79	73.26	-4.51	74.3	-3.47	76.79	-0.98
Station efficiency	17.15	17.93	+0.78	16.97	-0.18	16.95	-0.20	16.06	-1.09	17.49	+0.34	17.15	-
Calorific value of coal as fired		10,114		10,656		10,567		10,257		10,814		10,515	

W = lb. water per unit generated: Tr = Temp. rise circ. water
H = Total heat in steam: h = hotwell temp.

Number of Men Employed

Shift, salaries	20
Shift, wages	58
Time, main and repairs	131
Load factor on station. $\left\{\frac{\text{Units delivered}}{\text{Max. load} \times \text{hours}}\right\}$	33.68

The cost of coal per ton in that month was taken at 16s 6d. This figure is gradually becoming lower, and under better conditions of output and load factor it is certain that the total cost figures will be very much improved.

In logging the station performance, an attempt has been made to get results tabulated so that comparison can readily be made with other plants, and at the same time give figures which the operating engineer can easily remember. In the boiler house, the usual figure of pounds water per pound of coal has been improved upon in accordance with modern practice, and this is now given as equivalent evaporation per 10,000 B.t.u. The coal being sampled from the hoppers and tested every day, this figure becomes strictly comparable day by day.

A summary sheet of the daily log is also compiled, the sheet being drawn out for seven days. This tabular sheet, shown in the table, gives the daily performance compared with the standard which represents the average results under good running conditions. The summary sheet is not for the compilation of costs; it is provided so that the operating staff may notice any serious departures from the standard and take steps to rectify them.

The total coal consumed and units generated are plotted out per shift for each month, and the same is done for water. Then each month a base line is drawn on squared paper, which represents the coal per unit or the water per unit, less the station losses; that is to say if the coal line for the previous month is C=16,600 plus 1.714 K, then the base line is at 16,200, and the performance of each shift is plotted against this line. If any shift shows a great departure from the base, an inspection of the summary sheet should help to locate the cause of the disparity. Such a diagram for this station is shown in the chart.

A testing engineer is employed whose sole duty is to investigate problems on the economical operation of the station. He has complete testing equipment to determine the calorific value of the fuel, the quality of the feed water and for analyzing the flue gases. A typical test is given in the following table.

BOILER TEST AT DALMARNOCK STATION

Test on a Single Unit

Normal working conditions

Rate of steaming.....55,000 lb. per hour

	Per cent.
Heat transfer in boiler	59.4
Heat transfer in superheater	10.6
Heat transfer in economizer	9.75
Heat transfer in combined plant	79.75
Losses in flue gas	15.0
Losses by radiation	4.0
Combustible in ash unaccounted for	1.25
	100.00

Av. kw. induced draft fan motor 85.5.

Duration of test—4 hr. on induced draft.

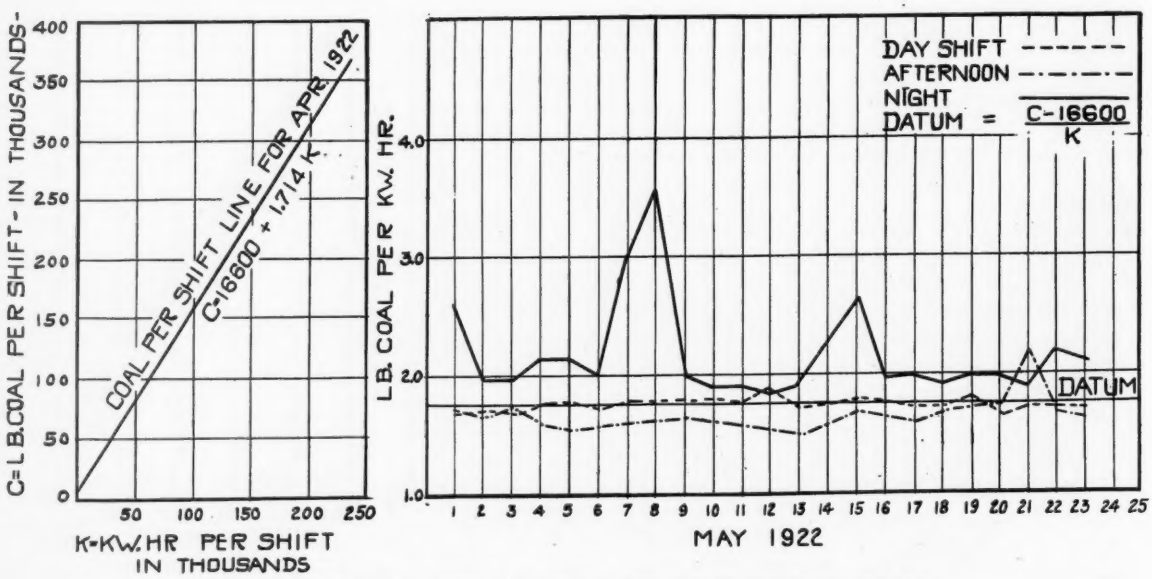


FIG. 6. COAL PER SHIFT AND DAILY FUEL CONSUMPTION IN STATION

Test results obtained on a turbo-alternator set corrected to standard conditions for the station.

Steam pressure, 250 lb. per sq. in.; temperature, 650 deg. F.; vacuum, 29.1 in.:—

LOAD IN KILOWATTS	LB. STEAM PER KILOWATT-HOUR
11,250	10.68
15,000	10.53
18,750	10.48

These figures were obtained without special preparation on the part of the turbine makers. The various measurements were made as accurately as possible both on the steam and on the electrical side. Test results under ordinary working conditions, showing the effect

of running the set: (a) from its own auxiliary turbo-alternator, and (b) from the works' sub-station supply:

NO. TURBINE

Averages over one hour's run

House Turbine Supplying Main Unit Auxiliaries

Steam pressure, 274 lb. sq. in. G.

Steam temperature, 725 deg. F.

Superheat, 310 deg. F.

Steam pressure after first exp., 74 lb. sq. in. G.

Barometer, 29.6 in. Hg.

Vacuum, 28.6 in. Hg.

Theoretical vacuum, 28.673 Hg.

Vacuum referred to barometer 30 in. Hg., 29.00 in. Hg.

Condensate temperature, 77 deg. F.

Heater discharge temperature, 130 deg. F.

Cir. water temperature, inlet, 53 deg. F.

Cir. water temperature, outlet, 65 deg. F.

Temp. rise of cir. water, 12 deg. F.

Circulating water, 26,100 gal. per min.

Total water per Lea recorder, 180,000 lb. per hr.

Kw.-hr. generated, 10.65.

HOUSE TURBINE

Steam pressure, 1st gov. valve, 219 lb. per sq. in. G.

Steam pressure, 2nd gov. valve, 25 lb. per sq. in. G.

Steam temperature, 710 deg. F.

Steam pressure at exhaust, 16 lb. per sq. in. abs.

Steam to house turbine, 10,350 lb. per hr. (calculated).

Average load, 348 kw.

HEAT BALANCE

Input, 14,127,750 B. t. u. per hr.

Heat in exhaust, 12,420,000 B.t.u. per hr.

Heat regained in feed water, 9,540,000 B.t.u. per hr.

Loss in heater, 2,880,000 B. t. u. per hr.

Heat cost in auxiliary energy per kw.-hr., 13,100 B.t.u. per kw.-hr.

Total heat cost of auxiliary energy, 4,560,000 B.t.u.

Heat balance, Multijectors and Feed Heater in Service—Electrical Auxiliaries Supplied from Main Unit Energy.

Main unit kilowatts, 17,000.

Steam consumption, 11.00 lb. per kw.-hr.

Heat cost of main unit energy, 14,972 B.t.u. per kw.-hr.

Power for electrical auxiliaries, 210 kw.

Expenditure in B.t.u. for electrical auxiliaries, 3,134,670 B.t.u. per hr.

Steam consumption of multijectors, 5,904 lb. per hr.

Equal to 8,017,632 B.t.u. per hr.

Temperature rise of condensate, 42 deg. F., 42 B.t.u. per lb.

Total heat regained in heater, 7,854,000 B.t.u. per hr. (ejector exhaust and entrained gases).

Therefore, Heat consumption of ejectors, 163,632 B.t.u. per hr.

Total expenditure in B.t.u. for all auxiliaries, 3,298,302 B.t.u. per hr.

It should be noted that these latter tests were only in the nature of preliminary rehearsals, only one or two observers being employed.

Why a Diesel Engine Fails to Fire

LOW COMPRESSION TEMPERATURE, WRONG INJECTION AIR PRESSURE, AIR IN OIL LINES, WATER IN OIL, ETC., ARE TROUBLES THAT MUST BE CORRECTED. BY M. S. HOWARD

WHEN the engineer first takes charge of a Diesel engine, he finds many things that are unknown in the steam plant. Some time, for instance, he will be face to face with the problem of why the engine stopped firing and went dead. For the benefit of those with a small amount of experience with oil engines, the several reasons for a failure of the engine to ignite the fuel will be listed and the methods of eliminating the trouble discussed.

A Diesel engine will fail to fire or stop firing for the following reasons: (1) too low a compression temperature, (2) late fuel admission, (3) low injection air pressure, (4) too high an injection air pressure, (5) air in oil lines, (6) water in oil, (7) water in injection air line, (8) leaky fuel pump check valves These various troubles will be taken up in order and the steps necessary to correct them will be shown.

EFFECT OF LOW COMPRESSION

THE CHIEF cause for the engine to stop firing on one cylinder is too low a compression pressure. The fuel is injected into the air compressed in the working cylinder. No electric ignitor or other means of supplying a flame to ignite the oil is used. The air is compressed to a pressure of around 500 lb. per sq. in. and this high pressure causes the temperature to become very high, just as the air from a tire air pump will get hot if the pump is worked fast. There is a ratio between the final temperature and final compression pressure depending upon the initial pressure and temperature. At 500 lb. final pressure, the air temperature will be around 1400 deg. F. with the suction air at 100 deg. This temperature of 1400 deg. F. is enough to ignite the fuel as soon as the fuel is sprayed into the cylinder. If the pressure fails to reach 500 lb. but only about 350 lb., this pressure is too low to give a high temperature and the oil fails to ignite.

The reason for the low compression pressure is sometimes hard to find. In the first place, the piston may be badly worn. In such instances, the wear is gradual and the engine does not stop firing suddenly. The engineer will find that each time the engine is started, this cylinder is slower and slower in starting to fire the oil; so if the difficulty has been growing worse, it is safe to think that the cylinder and piston are worn. This can be improved for a short time by inserting shims between the connecting rod butt and the crankpin box. Lengthening the rod in this way decreases the clearance space between the cylinder head and piston and raises the compression pressure. In case of very low compression pressure, reboring of the cylinder and a new piston is the only remedy.

OTHER REASONS FOR LOW COMPRESSION

LOW COMPRESSION may be caused by leaky air or exhaust valves. If either of these valves leak, some

of the air will flow out of the cylinder and of course the compression will be low. It is not hard to find a leaky valve, as the whistling can be heard by placing the ear at the intake. Also a leaky exhaust will give out a sneezing sound, easily heard if one has a test hole in the exhaust elbow. Grinding will soon put the valve back into running condition.

Broken piston rings will also allow air to leak down along the piston. This may cause the engine to stop firing suddenly. In most cases, the loss of compression isn't enough to interfere with the engine's running and usually the click of the broken ring can be heard. The cause of broken piston rings is either excessive use of lubricating oil or a poor grade of lubricating oil. In either case, the rings gum up and the gum cakes, causing the rings to freeze into place and finally break.

Detecting Low Compression

The only correct way to detect low compression is to use an indicator on the cylinder. By cutting out the oil pump feeding this particular cylinder, a compression indicator card is gotten. This card shows the pressure caused by the compression. It isn't necessary to connect up the indicator card to the engine crosshead or piston. If the drum is shifted by hand, a series of vertical lines are drawn and the height of these lines shows the compression pressure.

If the fuel valve is opened much after the piston has passed top dead center, the oil will not ignite. This is due to the low pressure caused by the piston moving away from the head. This can be fixed by retiming the fuel valve. Usually the fuel valve should open about 6 deg. before the piston reaches top dead center. If the opening is late, the clearance between the valve rocker arm and cam can be made smaller, if it is large. This will cause the cam to strike the rocker arm earlier. If the clearance is correct, or about 0.03 in. for most engines, the nose on the fuel cam can be shifted ahead.

This failure seldom occurs except after the engine has been retimed. Once in a while the engineer makes a mistake in timing and the engine fails to fire upon starting up.

Injection Pressure Must Be Correct

Since the oil is blown into the cylinder when the pressure is around 500 lb., by air pressure, it is necessary that the pressure of this injection air be higher than the pressure in the engine cylinder. If it is low, the oil will not be forced through the pulverizer discs and the engine cannot fire because there is no oil put into the cylinder. The air pressure must be around 750 to 1000 lb. On heavy loads and with thick oil 1000 lb. is not too high.

If the air pressure in the lines to all the cylinders is low then the engine will stop firing in all cylinders. In this case evidently the air pressure coming from the compressor is too low. The suction damper may be partly closed or a compressor valve may be leaking. If the pressure gages on the low pressure stage shows the usual pressure the trouble must be in the intermediate or high-pressure stage. Their gages will show the stage that is falling down. Leaky valves will be found the cause in most cases.

If only one cylinder stops firing, the air line to this fuel valve may be choked by a bit of waste or dirt. This can be found out by disconnecting the air line at the fuel valve and putting on a pressure gage. If the fuel valve has a drain connection the gage may be placed here and the pressure noted while the engine is running. The gage needle will vibrate quite rapidly and for this reason the gage cock should be barely cracked in order to dampen the vibrations.

If Injection Pressure is too High Cooling Results

If the injection air is too high, in blowing the oil into the cylinder the air will expand and cool the oil so that the temperature will be too low to cause burning. This is by no means a common occurrence and will happen if the pressure runs up to 1200 to 1300 lb.

If any air gets into the pump casing the pump plunger will merely compress the air and will discharge no oil. The engine will quit firing at once.

This can be prevented by seeing that the oil lines have no pockets for air to collect and that the supply tank is high enough for the oil to flow to the pump by gravity.

At times water is mixed with the oil. As soon as the water reaches the fuel valve and is shot into the cylinder, the engine stops firing. It will be found that all the cylinders fire irregularly or not at all.

Oil should be kept free of water and the suction line to the storage tank should not reach to the bottom, but leave 4 to 6 in. for water and dirt to collect.

If the fuel pump suction or discharge valves leak, too small a fuel charge reaches the cylinder. The cylinder will then fire very weakly. It is seldom that more than one pump's valves fail at the same time.

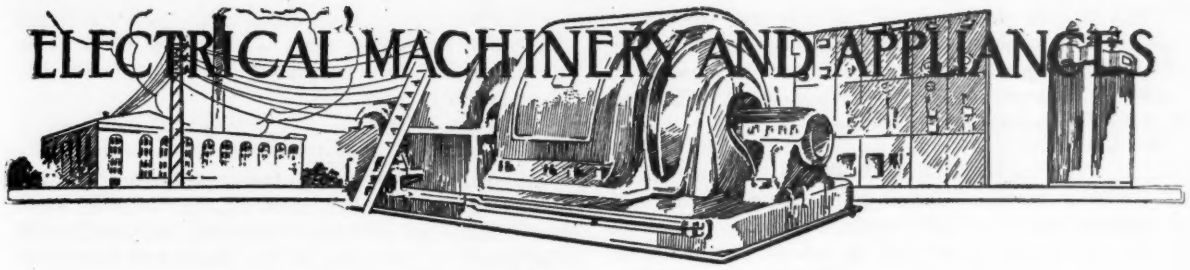
Leaky Fuel Pump Valves Should Be Ground

To stop the leaks the valves should be ground with extra fine grinding compound. If this isn't handy, powdered glass mixed with machine oil will do. If the oil used has been a heavy grade and is replaced by a lighter oil, it will be found that the lighter oil will leak by a small cut on the valve face where the heavy oil held without a leak.

The engineer will note that there are a number of things that might cause a failure. Upon studying the matter, it will be found that the cause of the failure can nearly always be discovered at once by the method of failure. When all cylinders lie down at the same time, the engineer hasn't much time to decide what is the cause. Offhand, should such a thing happen to me, I would at first thought decide it was either water in the oil or low injection air. The latter can be seen to by a glance at the gages. The moisture is detected by noting the oil coming from the pump drain.

The foregoing outlines several of the Diesel engineer's problems, and it is the hope of the writer that the operators of oil engines will read this and then see if the information does not help them over the hard spots.

Arrangements have been made by the U. S. Bureau of Mines for experimental work in the carbonization of lignite, to be performed during the summer at the University of North Dakota, Grand Forks, No. Dak. The work will consist of experiments in making lignite char, used for domestic fuel, without briquetting or further treatment. W. W. Odell, fuel engineer, will represent the Bureau of Mines in this work.



Electric Motor Drive in the Rubber Industry

HEAVY FLUCTUATING LOAD REQUIREMENTS AND VARYING SPEED CONDITIONS MAKE SOLUTION OF MOTOR PROBLEM DIFFICULT. BY GORDON FOX.

THE RUBBER industry is a very large user of power. As the extensive development of the industry is largely recent the use of electric power prevails. The principal operations in a representative plant may be classified as follows:

1. Preparation of the rubber, which comprises washing, kneading and mixing processes. It is in these operations that the bulk of the power is consumed.

2. Calendering or rolling the rubber into sheet form. The calender is perhaps the most important machine in the rubber mill.

3. Finishing processes such as fabrication of tires and tubes, belts, hose, rubber shoes and gloves and hard rubber and mechanical rubber goods.

Crude rubber is received in several forms but more commonly in the form of large chunks or balls, containing much dirt and foreign material. These chunks

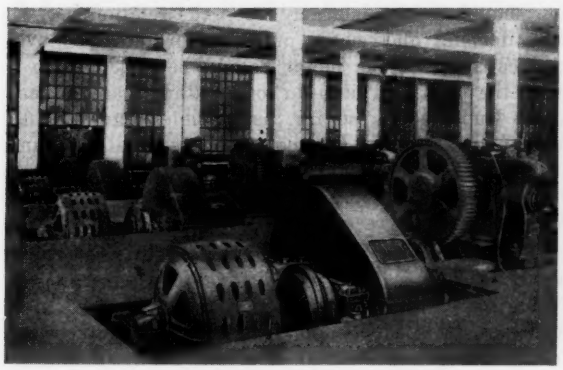


FIG. 1. WOUND ROTOR INDUCTION MOTORS (500 H. P., 514 R. P. M.) DRIVING RUBBER MILL LINES THROUGH MAGNETIC CLUTCH AND REDUCTION GEAR

are first soaked in hot water, to soften them, and are put through washing operations. The washing process, in its several stages, eliminates foreign matter from the stock and thus converts it from crude to pure rubber. The chunks are first fed to a disintegrating washer or "cracker." This machine ordinarily has two rolls about 18 to 22 in. in diameter and 30 to 60 in. long, mounted in a horizontal plane with perhaps ½ in. clearance between them. The rolls are grooved longitudinally or spirally with coarse rectangular grooves. One roll is geared to revolve about 30 per cent faster than the other. The crude rubber, in passing between those rolls, is crushed, cut and torn apart. Water, flowing through the rubber during its passage through the rolls, washes out part of the entrapped dirt. This operation is repeated by allowing the material to pass through the mill a number of times until complete disintegration is accomplished. The material is then removed and passed through a "creeping" or "sheeting" mill. This mill is similar to the disintegrating washer in all respect except that the roll corrugations are finer or one roll may be smooth. Further washing takes place in this mill and the product emanates in the form of rough, crepe-like sheets of clean stock. This material is next introduced into "breaking down" mills. These are similar to the washers but no water is used. The rolls are smooth, are steam heated and

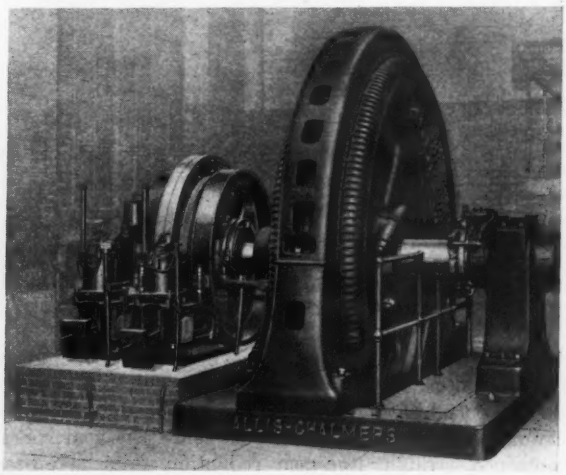


FIG. 2. SYNCHRONOUS MOTOR (1000 KW., 120 R. P. M., 2200 V.) DRIVING DIRECTLY TO RUBBER MILL LINE SHAFT. NOTE, MAGNETIC CLUTCH AND BRAKE.

both revolve at the same speed. Here the rubber loses its granular condition and becomes a creamy, plastic mass, taking the form of heavy sheets of pure gum.

All rubber milling machinery is somewhat similar in that the load demand is of a varying to widely fluctuating nature. This characteristic is more pronounced upon some machines than others and depends also upon whether individual or group drive is employed. The widest fluctuations occur at the disintegrating washers when the crude rubber is first introduced. The peak demands during this period may be three to four times the mean load, considering an individual mill.

The load of the "creping" mill is also subject to some variation, but to a much lesser degree than that of the disintegrating mill. Here the maximum peak seldom exceeds 200 per cent of the mean load. The load factor of an individual mill is about 50 to 60 per cent.

Method of Driving

Because of the fluctuating character of the load of rubber washing and mixing machines, there is much advantage from an electrical viewpoint, to be gained from group drives. The benefit arises because of the effect of diversity factor in smoothing out the load demand, diminishing the relative peaks and improving the load factor. From the point of view of minimum motor investment and improved motor efficiency and power factor, the practice is to be strongly recommended where permissible. It is, however, not advisable to carry the grouping too far as mechanical difficulties may then arise in connection with the transmission; six to eight machines are suggested as a limit of grouping.

The speed of the rolls of most mills is about 20 to 25 r. p. m. Where group drive is employed, the rolls are commonly gear driven from a mill line shaft passing beneath them. This mill line shaft ordinarily runs about 80 to 100 r. p. m. It is a common practice to

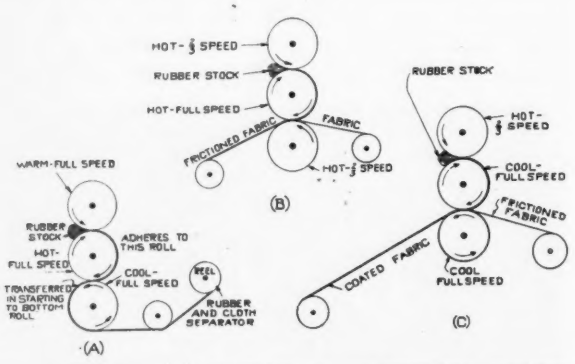


FIG. 3. (A) DIAGRAM OF CALENDERING PROCESS. (B) FRICTIONING PROCESS. (C) SKIM COATING

drive this shaft through a set of herringbone gears from a motor running about 500 to 720 r. p. m. In the most modern arrangement the pinion driven by the motor is either directly above or below the gear. Self contained, straight line gear reduction units have been installed in recent instances. Silent chain drive is also frequently used. Flexible couplings are commonly installed between the motor and the gear unit and also between the gear unit and the mill line shaft. A magnetic or pneumatic clutch is frequently installed between the motor and mill line shaft and a brake is nearly always provided to stop the mill line shaft quickly. Although the fluctuating nature of the load might indicate the possible use of flywheels, these are not commonly employed. Where but two or three mills are on one shaft a squirrel cage motor may be used. For larger groups a wound rotor motor is necessary largely from starting considerations. The use of the synchronous motor for driving mill line shafts offers several advantages. The principal benefit is that of high efficiency and power factor over a wide range of loads. Due to the extensive use of induction motors and the low load factor resulting from fluctuating demand, the power factor of rubber mill loads may be as low as 60 to 65 per cent. The influence of the synchronous motor is evidently helpful under such conditions.

Motor Sizes

Because of the many factors affecting the load demand of the individual mills, together with the varied effect of different methods of grouping, it is not possible to lay down any set rules for the selection of motor sizes. Such determinations should, where possible, be based upon tests of duplicate or similar mills working under similar conditions. The influence of grouping should be studied and the diversity factor determined. As previously stated, these values will vary under different conditions; however, analysis of a number of installations indicates that the motor capacity installed, on a single mill basis, for washers and sheeting mills averages about 1.6 hp. per in. of roll face, ranging from 1.25 to 2 hp. in different cases. For mixers the installed capacity on a single mill basis, ranges from 1 to 1.5 hp. per in. of roll face and averages about 1.4 hp. Where several mills are grouped the preceding values are discounted by the diversity factor. This is also subject to variation. Some values showing the general nature of this item are given below:

Mills in Group	Diversity Factor
1 or 2 mills	100 per cent
3 mills	85-90 "
4 - 5 mills	80-85 "
6 mills	70-75 "
8 mills	60-65 "

The fact should be borne in mind that motor selection should be based largely upon the relation between peak demand and motor pull out torque. The overload capacity of the motor should be called upon to carry the peaks. The mean load, rather than the maximum load, should, so far, as possible, determine the continuous rating of the motor selected and the range of loads to be expected should fall within the limits over which the motor operates with good efficiency and acceptable power factor.

Sixty cycles is the frequency used in most rubber plants. There is little or no advantage offered by 25 cycles so the prevailing utility frequency should be selected. It is a common practice to generate or distribute the power at 2300 v. Many of the motors are sufficiently large to permit their being wound for this voltage. The smaller motors about the plant are usually wound for 440 v. or 550 v. About 75 per cent of the power required in the typical plant is used in the rubber preparation processes.

Control of Mill Drive Motors

The control used for mill drive motors should be of the manual type, totally enclosed and as simple and fool-proof as possible as it is operated by inexperienced men. The motors are not frequently started but starting conditions may be rather severe where magnetic clutches are not used. The use of automatic control is not warranted. Provision must be made for reversing the motor to back out the mills. A low voltage release trip should be supplied and connected with the safety bars at each machine, for stop-

ping the motor in emergency. Inverse time element overload relays should be provided.

Safety Features

Milling operations are somewhat dangerous as the plastic and tenacious character of the rubber may entangle the hands of an operator and cause them to be drawn into the rolls. To minimize this danger, it is necessary that either the operator caught or any of his fellows be able to stop the mill almost instantly, that is, while the rolls travel but a few inches. A travel of 4 in. is considered fairly safe. Several means are used to accomplish this result. Where individual motor drive is employed the motor may be equipped with a solenoid brake which sets instantly when the circuit is tripped. A rather powerful brake is required. A safety provision is sometimes made by arranging to throw the roll driving mechanism out of mesh and permit the motor to continue to run. Where group drive is employed, arrangement may be made to plug the motor driving the group. This is objectionable, partially as depending on maintained power. Where a synchronous motor is used for driving the mill line shaft, dynamic braking may be arranged by disconnecting and short-circuiting the primary winding through resistance, with the fields excited. Heavy solenoid brakes may be applied to stop both motor and line shaft, a not uncommon arrangement. These methods are with difficulty made effective, as the torque necessary to stop motor and line shaft in the required distance is three to five times full load motor torque. Probably the best method, and one now in common use, is to install a magnetic clutch excited by direct current between the motor and the mill line shaft and to apply a brake for stopping the line shaft only. The clutch is released and the brake set when any safety stop is tripped, shutting down the entire mill line shaft. Most of the inertia is in the motor so that, with the mill line shaft isolated, a sufficiently quick stop can be made by means of a brake. Safety bars should be installed at every mill and so arranged that they can be readily tripped.

Calendering Processes

The rubber calender is a machine comprising a series of rolls, usually three in number, arranged vertically above each other, the compound being passed between the rolls and thus spread into sheet form. It serves three distinct functions. In calendering or sheeting, the rubber is rolled into sheets the thickness or gage of which is determined by the roll separation, the width being determined by the setting of knives which press against the center roll and cut the sheets into strips. In friction work, the stock is rubbed into rolls of fabric so that the cloth is impregnated with rubber compound. In the skim coating process, the stock is simply spread over the surface of fabric which has been previously frictioned.

The rolls of a calender are usually smooth. They are arranged for either steam heating or water cooling in order to heat or cool the compound, as required. The separation between the rolls is subject to fine adjustment. End pinions are provided by means of which the relative speeds of rolls may be changed. Figures 5—7 show the principles of calendering processes. In calendering, all three rolls run at the same speed. The top roll is warm, the middle roll is hot, and the bottom roll is cool. The rubber is taken off below the bottom roll and reeled with cloth between layers to prevent adhesion. For friction work, all three rolls are hot. The top and bottom rolls revolve about two-thirds the speed of the middle roll. The fabric to be frictioned runs between the middle and bottom rolls. The difference in speed between these two rolls causes the compound to be thoroughly rubbed into the fabric. In skim coating, the top roll is hot and runs about two-thirds the speed of the middle and bottom rolls, both of which are cool. The fabric to be coated is passed between the middle and bottom rolls.

A number of different methods have been employed for driving rubber calenders. Because of the adjustable speed requirement, individual drive is almost universal. Direct current motors are commonly employed. These may be such as to provide a 4 to 1 speed range by field control or a motor with combined armature and field control may be employed. It is rather difficult to obtain the desired stability and close speed regulation of large motors over so wide a range by field control. Moreover, large motors for use on two voltages can be supplied to meet the necessary power and speed requirements at lower cost. It is therefore a common practice, particularly for the larger equipments, to employ motors designed for a 2 to 1 range by field control in connection with a three-wire multiple voltage 115/230-volt system. The fact that reduced power demand occurs at the lower speeds renders this system feasible. The multiple voltage required may be obtained from a three-wire synchronous converter or a three-wire d.c. generator or from two generators connected in series. Where the unbalanced load is to be considerable, the latter arrangement is perhaps preferable as affording better voltage regulation with unbalanced load, voltage adjustment and simplicity. However, a number of calender motors may be fed from a single multiple voltage system, the diversity factor usually tending to minimize the unbalancing. The Ward Leonard control system has been employed, but is not widely used as it requires a separate generator for each calender motor.

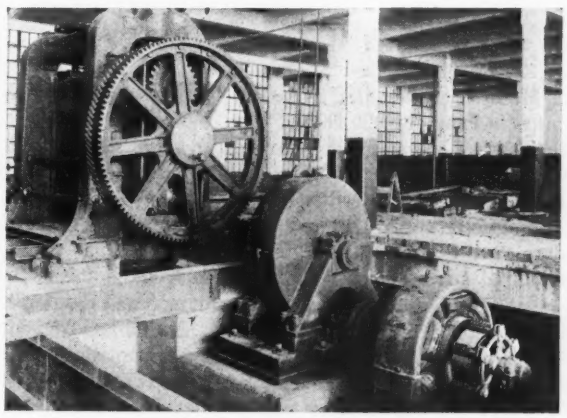


FIG. 4. RUBBER CALENDER DRIVEN THROUGH REDUCTION GEAR BY 250-HP. D. C. MOTOR

Primarily in order to avoid the necessity of conversion to direct current, some calenders have been equipped with alternating current motor drive. Wound rotor motors giving a 2 to 1 speed range by secondary resistance may be used on calenders to be employed for sheeting or for frictioning only. They are subject to the decided objections of waste of power and speed variation with change of load. Multispeed induction motors have been successfully employed on some of the smaller calenders of restricted output where three or four definite speeds will suffice.

The power required by a rubber calender depends upon many factors. The size of rolls and width of sheets produced have a direct bearing. The quality of the compound, the thickness of sheets rolled, the method of feeding material, temperatures and speeds all affect the load demand. A general indication of motor sizes used may be gained from the following table.

APPROXIMATE MOTOR SIZES FOR RUBBER CALENDERS

Size of Rolls		Motor—HP
Diam.	Face	
15	30	25
18	54	35
20	60	50
22	60	75
24	66	90
32	90	250

Motors for calender drive are fairly slow speed machines, a range of 225/900 r. p. m. being representative. The motors are connected through gear or silent chain, a flexible coupling being commonly installed between the motor and gear reductions.

Magnetic control of a full automatic or semi-automatic type is preferred for calenders. One of the principal advantages of the direct current motor is the possibility of dynamic braking to bring the calender to a quick stop in case of emergency. Suitable provision should be made in the control for accomplishing this purpose. The dynamic braking feature is of value both to safeguard the operator and to avoid material waste due to coasting. Safety bars should be provided at the calender which will cause the dynamic braking to be applied. In addition there should be provided a convenient push button control which may have provisions to start and stop—brake—reverse—slow down or inch for threading in and points for cutting in and out the field rheostat. After stopping, it should be possible to attain the previously set speed without adjustment. A reversing feature should be included for backing out the material in the rolls when desired. The usual low protection and time element overload features should be included. The field rheostat should be provided with fine increments and marked in yards of production per minute.

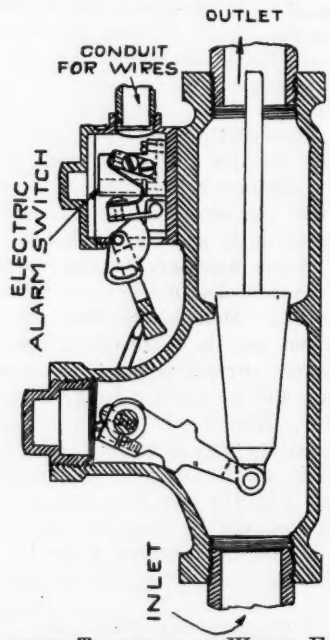
U. S. Civil Service Commission announces an examination for laboratorian (chemical, physical, engineering) on Dec. 6 and 7, to fill vacancies in the Federal classified service throughout the United States, including the Departmental Service, Washington, D. C., at $1200 to $1500 a year, or higher or lower salaries. Appointees whose services are satisfactory may be allowed the increase granted by Congress of $20 a month. Apply for Form 1312, stating examination title.

New Type of Water Flow Indicator for Transformers*

Novel Method of Measuring Water Flow Based Upon Movement of Conical Plunger. By A. M. Rossman

THE WATER-FLOW indicator herein described was developed primarily to provide a simple and dependable means of indicating the quantity of water flowing through the coils of a water-cooled transformer.

As shown in the accompanying figure, the principal moving part is a heavy conical shaped metal plunger which is free to move vertically through a circular orifice. Such a movement produces a change in the free area of the orifice which is inversely proportional to the increase or decrease in the cross-sectional area of that part of the plunger which lies in the plane of the orifice. When water is admitted below the plunger, it



Section Through Transformer Water Flow Indicator Showing Conical Plunger

causes the plunger to rise and take a position corresponding to the quantity of water flowing. When no water is flowing, the weight of the plunger causes it to assume its lowest position where it practically closes the orifice. Calibration tests made on one body with several plungers of different degrees of taper show that the plunger tends to assume a position such that the free area of the orifice is almost directly proportional to the quantity of water flowing.

The plunger is loosely pivoted to one arm of a bell crank. The shaft which carries this arm passes through a gland in the wall of the housing and carries a pointer on its external end. A movement of the plunger is thereby transmitted to the pointer which describes an arc over a scale, calibrated in gallons of flow per minute. A second external arm closes a switch and sounds an alarm when the flow falls below an adjustable, predetermined minimum value.

*Abstract of paper delivered before A. I. E. E.

It will be noted from the illustration that after the water flow is once established, the plunger cannot stick in the orifice because it is free to float in the stream of liquid, unhampered by any form of lateral restraint. Furthermore, there is small likelihood of the orifice becoming clogged, due to the gradual building up of a deposit of foreign matter, because the high velocity of the water through the orifice tends to scour the surfaces of both the orifice and the plunger, thereby preventing the accumulation of foreign matter. This cleaning process is further assisted by the constant lateral movement of the plunger and its occasional vertical movement during inspection or readjustment of the flow.

In calibrating these devices, it is found that the same curve is obtained irrespective of whether the flow is adjusted by a valve located in the inlet or in the outlet pipe. Furthermore, the calibration curve, obtained by starting with zero flow and increasing to the highest point of the scale, is practically the same as the curve obtained by starting with the maximum flow and decreasing to zero, thereby showing that the friction between the shaft and the gland is small compared with the torque due to the heavy plunger.

Several of these devices have been in continuous service on transformers in the central and the southwestern states since the summer of 1920, without receiving any attention other than routine inspection. One of these, after being in service several months on water which carries a large amount of suspended matter, was opened up for inspection, and it was found that the plunger and the entire inside surface of the housing as well as the interior of the piping system were coated with a green slimy fungus growth to a depth in some places of ⅛ in. This deposit apparently had no detrimental effect on the operation of the indicator, although it may have affected its calibration by restricting the free area of the orifice. A later inspection, made shortly after the transformer cooling water was changed from the raw to treated water, showed that this fungus coating had practically disappeared.

The operators at the different stations at which these indicators are installed have been quick to learn that they can easily "feel out" the operation of the indicator by lifting or forcing down the pointer and then releasing it and allowing it to come to rest at its original position. This is an almost infallible test of whether or not the plunger is floating properly in the water circuit.

While developed primarily for use on water-cooled transformers, this indicator is adaptable to many other applications, involving the measurement of the flow of liquids in pipes.

Getting Next to an Absorption System

SOME POINTS THAT WERE LEARNED IN PUTTING AN OLD SYSTEM IN WORKING ORDER. BY JOHN H. RYAN

SEVERAL YEARS ago, when I had decided that my swell job in a small town shoe factory did not offer the proper contact with the outside world, I migrated to the city. The job which I eventually landed was with a storage warehouse where a part of the equipment included an absorption system.

The plant was a growth. It started with motor driven elevator pumps taking central station current and when, in time, general business got bad with a consequent increase in the storage business, they accumulated some money and decided to build an annex for the storage of furs. To cool the new rooms, they bought a 30-T. exhaust steam absorption refrigerating outfit. To furnish the exhaust steam they bought boilers and electrical generating sets to drive the pump motors. The lighting load was very small and the alternating current, two phase generators and motors were about the same size, so that when a motor started up the lights would almost go out. They were running a 75 hp. engine all night with a load of about twenty 25-w. lamps. A small steam driven elevator pump would have been the thing to buy, as it would have run most of the time and given satisfactory service for slow freight elevators.

The first season, they did not get much space let and the engineer managed to hold the temperatures in the lower room in use. The next year, they got some large store contracts and the service from the refrigerating system was poor. The engineer made some changes in the pipe connections and got some additional apparatus, but he could not hold the room temperatures and he maintained that the rooms to be cooled required a larger machine and for proof exhibited his daily log sheet which showed the machine was doing 40 T. of refrigerating effect in a day.

No Loss Due to Poor Insulation

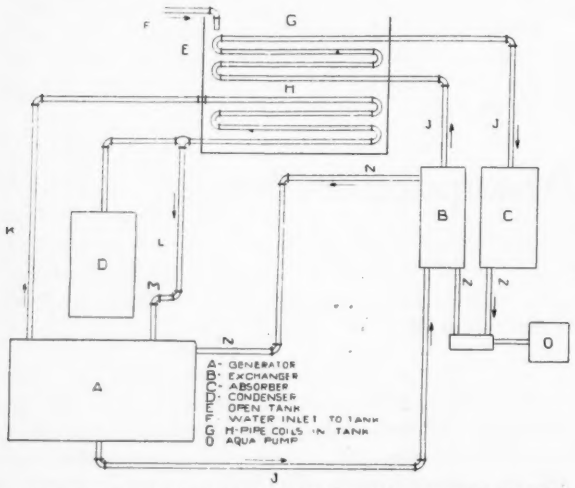
THE INSULATION of the rooms and air ducts was first class. It consisted of galvanized iron cans 6 ft. long, 3 ft. wide and 6 in. thick filled with mineral wool and the seams soldered. The cans were set in the walls on their 3 ft. edge so that the mineral wool could not settle much and if it did settle in any individual can it left an absolutely dead air space. The brine piping, the cooler and pumps were insulated with cork and the machines and piping were erected in such a way that no pipe or part was nearer than 6 in. to anything; this gave ample room for the full thickness of cork at all points and there was not a spot of frost showing through the cork as evidence of leaky insulation. Notwithstanding these proofs of good insulation and the large capacity the machine was doing, the fact still remained that the fur storage rooms were continually warming up and so my predecessor looked him up another job and yours truly stepped into the spotlight.

I had never operated a refrigerating plant of any kind and had never seen an absorption plant until I went into this one to run it; but I had recently obtained a first-class license and when those Massachusetts examiners asked me where they use horseshoe nails around a boiler, I had the answer right with me. I had a whole tool chest full of knowledge, but some of the tools were new to me and I had to learn how to use them. As I thought that a plant in working order would continue to run until I picked up the routine of operation, I became a disciple of Brodie.

My Job as Chief Engineer Bgins

The night engineer who had just done a 36 hr. stretch was very tired and so he took just enough time to show me the expansion valve to the brine cooler and the valve controlling the entrance of the weak liquor into the absorber and then went home. Thus I was officially installed as chief engineer, standing on my hind legs and thinking in circles.

Every few minutes I would go the rounds; out into the boiler room, then to the elevator tanks, then pumps and motors, and the generator sets. This stuff was all familiar to me and I felt among friends and it would give me courage to go back and look at that collection of six circular tanks all nicely lagged and banded with brass. The thought running through my mind was: I wonder which is which, how they tell what is going on inside of each tank and whether they are working right or wrong. The brine pump, which was running quite fast, was a simple duplex and I made friends with that right away.



WHAT THE LAYOUT OF THE ABSORPTION SYSTEM LOOKED LIKE

The aqua pump was of a slightly different design from the steam pumps I had been used to, but I soon reasoned it out. I found that the steam end is made extra large because it sometimes has to pump against pressures twice as high as the steam that drives it. The stroke is made long and the clearance in the ammonia end is as small as possible because the strong aqua is near the boiling point and the pump would get vapor bound if it had a short stroke and large clearance. The bunker room and brine coils with the fan and engine were simple and similar in operation to the system of heating we had at the shoe factory, the only difference being in the heat carrying medium; for heating, we used exhaust steam and here for cooling, brine was in use.

In a few days I had it doped out that the large horizontal tank was the generator which separated the water and ammonia by boiling. The small horizontal tank above the generator was the exchanger and it was an economical device similar to a feed water heater. The idea is to get the strong liquor into the generator as hot as possible and it will require less steam to boil off the ammonia.

The weak liquor drawn from the bottom of the generator should be as cool as practical to get it, before it enters the absorber. In this way, it will absorb the maximum amount of ammonia gas and require less cooling water to carry off the heat generated by the chemical combination of the ammonia and water. It is usual to arrange to have the strong and the weak liquor pass close to one another in opposite directions so that they may exchange their heat and the place where this is done is called the exchanger. The first vertical tank was the ammonia condenser and alongside of it and slightly larger was the absorber. The brine cooler, also of the cylindrical type, was the first unit I had located. I knew that by the frost on the inlet side of the expansion valve.

Moths Come to Life at 40 Deg. F.

While I was getting acquainted, the operating conditions remained practically the same. The daily log showed the same capacity, but in four days the rooms showed a temperature of 38 deg. F. or a loss of 1 deg. The brine came back from the bunkers at 32 and we sent it out from the cooler at 27 deg. F. Moths come to life at 40 deg. F. and commence to make up for lost time. The condition was serious, as the company would have a lot of cancelled space and establish a poor reputation. I had frequent visits from the manager, who brought in agents for refrigerating machines. There was talk of getting another machine in a hurry and I could talk of lack of capacity, heat insulation and effect of exposure, the ammonia was not as good as in the olden days, or any allied subject my visitors happened to speak about, so you see in five days I became a full fledged refrigerating engineer,—almost.

There was a small vertical tank about 7 ft. high by 4 ft. in diameter that formed part of the system. It was connected on the brine line on the suction side of the pump and there were no valves on the pipes near it and no other connections but the brine pipe coming back from the bunkers and the one going to the suction of the brine pump. I could not make out what use it was unless it was some sort of a filter. I was not quite satisfied in my mind so I got a short ladder and got to the top of it. I found that there was a door arranged in the top lagging which I soon opened. The tank was quite small inside the insulation and also quite empty. There was a little brine running in at one side, but the brine pump drew it right out and I could hear the brine pump getting air at every stroke.

Then it dawned on me that the tank was there for expansion purposes and it would prevent excess pressure on the system when thawing off coils or the like. I got busy right away and hung a bag of calcium in the tank and ran some water through the calcium until the tank was two-thirds full. I knew the calcium would not dissolve so quickly, but our temperatures were high and the circulation of brine through the tank would dissolve the calcium inside the bag and there would be no danger of lumps getting into the system. It is a slow job making calcium brine and I was afraid that the brine pump might get air bound and we couldn't afford to shut down a minute in the condition our rooms were in.

Things Begin to Go Wrong

Noontime came and I looked around to get the pressures and temperatures to put down on the daily

log and my heart missed three beats when I found that there was no difference in the temperature of the brine coming into the cooler and when it went out. I did more foolish things in the next 10 min. than Charlie Chaplin does in a year. I manipulated every valve in any way connected with the operation of the refrigerating apparatus and still the machine did no work. I looked all through my new stock of mental refrigerating knowledge and I couldn't find anything to help me in the problem that confronted me.

I knew when I was beaten so I called up a good friend, a compression machine man who knows refrigeration inside and out. My knowledge was mostly outside, like the brass bands on the lagging, neither of which had any effect on the operation of the plant.

He came over and got my story about the machine being too small for the work we had to do, still we were able to get 5 deg. difference on our brine. He grunted and wanted to know just what I did today that I had not done on any other day. I explained that I operated the plant the same, but I had found the expansion tank empty and put in enough brine to prevent the pump getting air bound.

"Aha!" he exclaimed, "now we are getting somewhere. Yesterday and maybe a year of yesterdays you were pumping around 190 gal. of air and 10 gal. of brine per minute. Your bunker is on the same level as your pump and you have only the friction to overcome and the pump did not have to compress the air and make its operation noticeably jerky. As 190 gal. of air is about 2 lb. cooled 5 deg., it would do about 2 heat units of work per minute which amounts to 1 ton of refrigerating in three months. The 10 gal. of brine you were circulating did about two tons a day and if you slow down that brine pump until it is pumping only 10 gal. a minute, you will still get your 5 deg. of cooling of your brine, but the machine won't be doing any more work. There is nothing the matter with your brine system; it just happened that you found out there was something else wrong, with the aid of the brine system. No doubt the brine was lost around the piston rods of the brine pump. I see you have cast-iron drip pans under all the pumps; they are very neat, but you should have a separate pan under the brine end of the pumps, drain the brine pan into a pail and when it becomes a nuisance emptying the pail you can repack the rods.

"Now, we have got to locate the trouble in the ammonia system," he continued. "How about the cooler? Do you know whether the coils are frosted up with aqua or not?"

They were not, as I had drained the cooler into the absorber, when I found there was something wrong.

"How about the strength of the charge? Does the machine make anhydrous?" my friend asked. "I see you have no receiver and the condenser glass is empty."

I replied that the anhydrous rose in the glass all right when I had the expansion valve on the cooler closed while I was draining it of aqua. "Would the absorber make strong liquor?" he asked. "Yes," I replied, "the aqua pump got vapor bound when I was draining the cooler and the pump was cold at the time."

"How about the generator making weak liquor?" he continued. That I did not know, as there was no way of telling from looking at the plant and there was no salometer on the job.

But my friend whittled a piece of wood smaller than a lead pencil and drove a tack in the end of it. Then we drew a sample of weak liquor from the bottom of the generator and set it to cool. Then we took a sample of the strong liquor from the aqua pump and when both samples were at the same temperature the stick sank a lot lower in the strong liquor, thus proving that the generator boiled out a lot of the ammonia.

Some Further Investigations

Next, he spied a long, flat, open tank, up at the ceiling, that had pipes running to it from various units of the system. I explained that contained two pipe coils, trombone style and made up with close pattern return bends. One was made of 2½-in. pipe and was used as a dehydrator to condense the steam out of the ammonia gas on its way to the condenser. The other coil of 1¼-in. pipe was a weak liquor cooler and it further cooled the weak liquor on its way from the exchanger to the absorber. He climbed up and looked in the tank and felt of the water and piping and when he came down he said all the trouble was up there. With a piece of chalk he drew a line sketch of some parts of the plant on the cement floor.

It took in the parts of the absorption system affected and was about as shown in the accompanying diagram, in which A is the generator; B, the exchanger; C, the absorber; D, the condenser; E, the open tank; F, the water supply to the tank; G, weak liquor cooler, and H, the dehydrator, or rectifier as it is sometimes called.

How the System Operated

The operation of the system is in this manner: Ammonia gas is liberated in the generator by boiling, heat for the purpose being supplied by steam coils in the generator, A. The ammonia gas passes through the pipe K and the coil H, to the condenser, D. Any moisture in the ammonia is condensed out in the coil H and returned to the generator through the pipe L. The trap in the pipe at M is to prevent the ammonia gas from short circuiting to the condenser direct through pipe L. The weak liquor leaves the generator A, at the bottom through the pipes marked J, and passes through the exchanger and then the coil G, from there passing on to the absorber. The arrows show the direction in which the ammonia flows through the system.

The weak liquor picks up another quantity of ammonia in the absorber C, and the strong aqua travels through the pipes marked N, into the aqua pump O, then through the exchanger and into the generator again.

My Friend Explains What Was Wrong

"Now," he began, "your weak liquor arrangement is good. The exchanger takes out considerable heat and the coil G helps a lot. You have lots of well water at 52 deg. F. and the weak liquor layout is very economical. But the dehydrator H should not be in the same tank with the weak liquor coil G. You are putting well water into that tank at 52 deg. F. and it is coming off at about 85 deg. F. That dehydrator is acting as a condenser and the liquid ammonia is running down pipe L back into the generator and very little of the gas reaches the condenser D.

This is the reason for your greatly reduced capacity. If the coils in the tank E were reversed in position it

would be possible to work them both in the tank, but it is not a practical layout. If the coil G was on the bottom instead of coil H the cold water would cool the weak liquor and the warm water as it rises would cool coil H enough to take out the moisture.

"You notice that pipe L is about blood heat and it should be too hot to hold your hand on. The water coming off the dehydrator should be 140 deg. F. Shut the water off on pipe F altogether until you can see vapor rising out of tank E and see how your capacity will jump up."

I did this and inside of an hour I was getting a big difference in the temperatures in and out of the cooler, and things soon began to get right in the rooms. I had them down to 16 deg. F. in less than two days.

Before my friend went out that day I asked him how he knew that there was something wrong with the operation of the plant. There were no leaks, the pumps were running in good shape and I could see no visible signs of trouble; yet it must have been there in plain sight.

He replied that his first look at the manner in which the apparatus was installed showed that it was put up by people who knew their business and the brine pump running so fast and the aqua pump not speeded up in proportion showed that the manner of operation was at fault. "The coil G," he said, "was the idea of your predecessor and it worked fine when you consider the coil alone; but he neglected to consider the effect of the cold water on the coil H; it is quite simple when a little common sense is applied." He was right—it was common sense more than engineering knowledge that I required.

Accident Prevention in Public Utilities*

By Charles E. Morrison, Vice-President and General Manager, Utilities Mutual Insurance Company

PERHAPS the simplest way in which to develop a theme, with the foregoing as a title, would be through a careful comparative statistical analysis of conditions as they existed among the public utilities of say 10 yr. ago and as they exist today and, in a measure, this method will be adopted. But, on the other hand, it may prove more interesting and instructive if we treat the topic in rather general terms and try to discover whether some of those basic, underlying principles which maintain in all accident prevention work do not apply in proving our premise.

I think it is safe to say that accident prevention, as now understood and practised, is of comparatively recent growth and that each of us will concede the deeper significance which attaches to the expression than was the case even in the very recent past. It is true, the public utility executive has always realized, perhaps in a rudimentary way, that it was inadvisable and costly to electrocute, asphyxiate, or run over one of his own employes, or one of the public, but I am absolutely safe in saying that therefore, at least, he felt more concerned over accidents to those outside his organization than to those within. The reason is, of course, obvious, for immediately an accident was translated into financial or economic terms that which was apparently least costly was naturally least to be feared. And it was only human, since all business is based upon whether the last line in the balance sheet shows a surplus from operations, or no surplus at all.

The great incentive then to accident prevention, both in public utilities and in industry, was the realization that accidents to the public or the loss of an employe meant the loss of money, and perhaps this became more distinct and concrete when the states, one by one, began to penalize industry for accidents to its employes through workman's compensation acts. We all remember, not so many years ago, either, when the insurance carrier, on notice of accident to one of our employes, would immediately start to establish legal objections to all inability or attempt to barter with the poor unfortunate or his dependents for the cheapest settlement that could be made. Thank God, that day is gone and may He have mercy on the souls of those human vultures who used the ignorance and gullibility of some of our less fortunate brethren to profit at their expense! And may we not take time to remark parenthetically that such a change in conditions represents progress of the most substantial character.

Accidents Not Actually Necessary

There can be no doubt, either, that these questionable practices were a vital and potent factor in inducing the states gradually to impose compensation laws, in order that such vicious practices might be eliminated and that industry itself should be held, at least partly, responsible for accidents incurred by employes. In some states the degree of this responsibility is represented as two to one, the employer assuming to pay two-thirds of the wages received by the employe, while in other jurisdictions this is materially reduced. When these acts became effective, therefore, industry in general, and the public utilities especially, because of the heavy burden due to the more hazardous nature of their work, began to consider a little more carefully whether it was actually necessary to have so many accidents, with the consequent payment of so much money in compensation indemnities, they began to study ways and means to reduce them.

You will see from this, then, that the original and primary motive was economic in its application. While it is true many kindly disposed, broad-minded executives were prompted by the thought of humanity and the reduction of suffering, nevertheless the majority had not awakened to the fact that sympathy may be legitimately capitalized and made to yield large dividends.

In reviewing some of the records of the N. E. L. A. in connection with accident prevention to secure evidence, I was much startled at what I found. In the first place, do you realize that this association, which I take it is typical and representative of all the national public utility organizations, did not, in any substantial way, take up accident prevention work prior to 1914? In that year the Accident Prevention Committee of the

*From paper presented at National Safety Council Convention.

N. E. L. A. made its first annual report. Do you appreciate this, its first, and that only 8 yr. ago? At the convention in June, the committee displayed the first exhibit the association has ever had, consisting of photographs, safety data and various appliances. It showed a film for the first time. In the report it was noted that safety was arousing the interest of industry in general, that education was proving effective and that under organized effort two out of three accidents might be eliminated. Comparative statistics were presented showing the per cent of accidents due to negligence on the part of the companies and the per cent of accidents due to negligence on the part of the employe. It also very briefly cited one or two examples where accident prevention had actually decreased the number of injuries.

Importance of Prevention Spirit

It was said then, and it holds equally true today, that "The greatest factor operating toward the prevention of accidents is not the prevention device but the prevention spirit," and it was also indicated that accident prevention may be justified on the ground of elimination of human waste, even if not from the humanitarian standpoint. How far have we come along the road since then? Let us skip the intervening eight years and see what sort of a report the accident prevention committee of this same association brings in at the forty-fifth convention, held in Atlantic City in May, 1922.

In contrast, I wonder why the committee has seen fit to adopt a tone of pessimism as to the progress and accomplishments that have been made. Let me first quote their premise: "Primarily, accident prevention has for its purpose—(1) Increased efficiency, (2) elimination of waste, (3) conservation of cash, (4) cutting of production costs, (5) saving life, (6) promotion of better health, (7) reduction of mistakes and accidents and (8) development of standards of design, construction and humanitarian principles.

From their report it would seem as if the committees felt that little had been accomplished, but I think their findings and the facts contradict their own statement. Let me quote: "For many years, the Accident Prevention Committee has presented practical and helpful suggestions for the elimination of industrial accidents [in which we concur], yet its experience shows that in many instances comparatively little has really been accomplished in the way of reduced accident costs [which we do not accept]. This unimproved record may be due to the lack of interest. This remains unexplained."

Then the committee goes on and presents a report which for thoroughness and breadth of scope is far beyond the wildest dreams that anyone might have had even as recently as 1914. Could anyone have imagined a few years ago that in a decade accident prevention would have risen to such importance that a great and growing national industry, with $4,600,000,000 of invested capital, would have the time and the desire to put its stamp of approval on a report like this, filled to overflowing with suggestions of ways and methods of procedure? These, for example, are some of the topics discussed in that report: "Resuscitation," "Economics of Accident Prevention," "Hydraulic Plants," "Fire Prevention," "Apparatus," "Illumination," "Grounding of Transmission Lines," "Devices and Appliances," "Health Promotion." Have we not come a long way since 1914?

Growth of Public Utility Section

In the Council itself, the Public Utilities Section has grown from a very small beginning in 1916 to a membership of approximately 250, and if we consider that a number of these members are large holding corporations, in some cases with many subsidiaries or serving a large territory, it is reasonable to assume that the figures would be greatly multiplied were they placed on an individual company basis or on the basis of the number of communities served.

It has been stated that the average cost of accidents on electric railways varies from 2 per cent to 17 per cent of the gross receipts, while, on the other hand, it is known that where intensive accident prevention is employed this has been reduced below the lower limit and in one case for the year 1921, it was reported as only 7/16 of 1 per cent.

Comparatively few years ago there was little, if any, organized safety work. Today we have here hundreds if not thousands of representative men, from all sections of the country, who are interested, most of them as a livelihood in this one topic. Do you imagine that that part of the younger generation which is going to make its mark is going to pass by all this accumulated data showing that accident prevention is an economic necessity? Never! If some of them do, they will be left behind by those that do not. I venture to state that there isn't a man in the public utility industry in the United States but that knows something about accident prevention, and if this can be, and has been, accomplished in less than a generation, what may we not expect of the future when the hard-boiled variety has died off or been eliminated?

A Peculiar Engine Runaway

To warm up a semi-Diesel engine, the cooling water had been shut off and part of the load had been thrown on. The engineer, busy at something else, forgot to open the water in time. Suddenly the engine ran away. On seeing the speed increase, the engineer ran to the fuel valve and shut it off, thinking that something in the governor had gone wrong; but the engine did not slow down and the compression relief lever had to be pushed in to stop the engine. Once, stopped, one could hear steam sizzing out of a pipe union.

The piston which was always getting plenty of oil and was observed to be in a good condition a few minutes before was found to be absolutely dry. No other reason for this runaway can be seen than that the lubricating oil in the cylinder was so hot that the compression set it off as fuel when the flash point was reached.

Of course the engine could not have run much longer in this manner and it was stopped just in time. Even with the necessity of constant watchfulness always in mind, an oversight will sometimes occur with results that might prove disastrous. Chas. Labbe.

The Boott Mills, of Lowell, Mass., will erect a hydroelectric power plant to be constructed at a cost of $40,000. Turner, Millspaugh & Safford, Boston, are the engineers.

Saving Losses by Paying Men

WISE MANAGERS OF PLANTS WILL GO SHARES BY JOHN U. MORRIS

BEFORE proceeding further about difficulties with and remedies for power plant machinery, from the operating engineer's standpoint, I would like to offer a few suggestions about the supervision of the men operating the prime movers and auxiliary machinery.

We will assume, as is the case in the average power plant, that reliability and efficiency are the fundamental factors for consideration. We will assume, as is also the case in the average power plant, that there is a great deal of waste in operation which could be prevented, excluding the boiler room. Of course this last forms the bulk of inefficiency found in the everyday plant, hence the great stress laid to that department by the managers.

Much waste and inefficiency can be curbed by rules and regulations but, speaking as an engineer, I think by far the greatest room for improvement lies with the man being on the job every day. A manager, superintendent, or even a chief engineer, regardless of his previous practical experience, cannot apprehend the numerous little leaks, losses or troubles, unless he is right down operating each machine daily himself.

For example, we will take one instance in a power house that had 10 units; each unit had its own circulator and each circulator had two syphons for raising the water. Out of those 20 syphons, four or five and possibly six were always leaking a little, all the time. When one would leak badly enough to attract someone's attention, the valve would be ground in or renewed. By rough calculation, I would say at least one or two hours a week were spent in overhauling those valves. That means that every year a total of from one to two weeks of labor was used to maintain these valves in only a second rate condition; and that has been going on that way since the plant was built, about 18 yr. ago. Only a small item, to be sure, but add together a multitude of these small items and you have an extremely large one, besides an accounting for all the make-up feed water.

Next is the question, how can these losses be avoided without impairing the plant's reliability of service? Most steam plants, including those aboard a ship, employ enough men to be consistent with safe and reliable operation, and no more. When looking for the greatest efficiency from a given design of engine equipment, they draft rules and regulations and hire laboratory men to check up the results. This may be all right, for this permits of tests and observations that the engineer cannot make; but after all is said and done, and the report lying on the superintendent's desk compares favorably with that of other similar plants, there is still room for the operating engineer to save many times his salary; and, strangest of all, I have never talked with more than one or two good operating engineers who were not aware of the facts.

Of course, in some cases, supervising methods prevent an engineer from diligently pursuing waste, and in other cases it may be lack of equipment, but the greatest damper of all is nothing more nor less than the lack of incentive. In other lines of business a man will work and ponder over efficiency, not necessarily for the company's gain, but for his own information, thus making himself more valuable to some other concern in the same line of endeavor. Power plant conditions are different. The general trend of managers employing engineers, in central stations especially, is to get an engineer when young and keep him in the same plant for the rest of his life. Naturally, the employe's first concern is to make a good impression, for where such positions have few turnovers, and the salaries are pretty fair, his outlook is to keep what he has got.

Diligently pursuing losses in the plant is another proposition altogether, and a somewhat more complicated line of work than the former. In order to accomplish anything, all hands must co-operate and everyone must be busy, with his mind on his work at least 80 per cent of the time, instead of about 5 to 10 per cent as is ordinarily the case. Knowledge of the theoretical points and cost problems should be kept in mind by the operating men (that is to say the men actually in overalls and taking care of the equipment) just the same as by executives. One might say, reading this article, that such engineers do not stay engineers. Quite right, but why? This brings us back to the same thing again, namely: no incentive.

It is somewhat the same proposition as socialism,—government ownership of everything,—and all such wonderful ideas. They all wind up a complete joke for the reason that they fail to observe the fundamentals of human nature. A man works for one of two reasons; viz., because he is indolent and somebody makes him, or because he has something to work for.

Some capable managers firmly believe they can *make* the brainy man work. They may be able to sometimes, but it is always the start of trouble because such tactics tend to separate responsibility from authority and that is the cause of all trouble. From my observation, I firmly believe that most power plant executives overlook these simple facts and that some means should be contrived to pay the men actually operating, a bonus for efficiency and reliability. Note I include the latter, for if one is sacrificed for the sake of the other, neither will be useful. Results of operation in figures and facts, should also be given to them that clear and concise thinking from the standpoint of economies will be possible.

Such methods would raise the standard of the engineer, consequently the standard of the executives, for a man rising from the ranks would naturally have to be that much more capable to go ahead of his fellow men. Thus efficiency would be accomplished in more ways than one.

As an example of what may be done, take a plant having six or seven vertical units which are used on peak loads and for emergencies when a unit is wanted in a hurry; or a station containing machines used only in emergencies, such as plants working with hydroelectric stations. The engineer in charge of the watch generally keeps pretty well posted on the weather con-

ditions and, if things look dubious and there is a possibility of a machine being needed in a hurry, he "gets the water over on one of the circulators" as a precaution against being late in starting up the unit. Such practice is especially necessary with a plant located near the seacoast where the circulating water is drawn from a tidal waterway. If the machine took longer to get up to speed than usual, a low tide would be no excuse. So we find many times that circulators are run for several hours in order that the unit may be ready in an emergency. Now, if all joints, shaft packing and water boxes are absolutely tight, the circulator system once in operation will hold the water indefinitely even though the circulator pump is shut down. Impeller seals would have to be left on, obviously, but this is a practice rarely met with, although it is far from impossible. In fact, all that is necessary is some work on the part of the engineer to locate the leaks and seal them.

Still another example of air leaks is the condenser itself. Some companies make 3 cu. ft. of air a minute per 25,000 sq. ft. of cooling surface, the permissible limit. If a particular condenser had remote leaks that brought the figure up to 8 or 10 cu ft., I have yet to see an engineer who would do any great amount of work looking for them. In such cases, if a water test fails to show anything and several have had their try at "looking around," the condenser is put on the sort of "impossible" list until the next general overhauling. Many times, after the general overhaul, the company is in a rush to use the machine and all the little troubles will go unattended. The engineer says "if the boss doesn't care, I don't see any reason why I should."

On the other hand, if a bonus was paid on the efficiency of plant performance, the engineer would work in an entirely different spirit. He would also see that, for the company to pay the largest bonus it might require an additional good engineer to help keep down the losses.

Statement is made by the general superintendent of the Duquesne Light Co., of Pittsburgh, that on a basis of two-unit operation, they can run 39,000 kw. of turbine capacity per man. Though very efficient from a labor standpoint, such figures could be used as a basis for figuring a bonus. In other words, any additional men needed would have to be paid from the percentage of the bonus that the employes got. Outage losses could also be figured in, so that a machine requiring general lay-up would be as much to the engineer's disadvantage as it would be to the company's.

If any Power Plant Engineering readers have given any sort of efficiency bonus system a trial, I think the enlightenment of the "trade" on the subject would be of great service to us all.

EVERY TON of cement you buy takes the equivalent of more than half a ton of coal in heat and power to make it—more than 200 lb. that is to the barrel of 376 lb. Burning cement is only one of the heavy fuel consuming operations in cement making. A medium size kiln's output is 25 bbl. an hr. and in that time 3500 lb. of coal must be blown into it.

Making Turbines Noiseless

By H. H. LUPINSKI

WHERE LARGE amounts of power are to be generated, steam turbine possess certain advantages over reciprocating engines. For certain purposes, however, such as the generation of power in large hotel plants, the turbine is quite noisy and as a consequence at many hotels, the preference has been given to engines.

The engineers of the new Hotel Ambassador at New York were not satisfied to follow this practice, however. They preferred to use turbines, if it was possible to do so, and felt convinced that if the machines were properly installed, their slight hum could be suppressed. They, therefore, drew up specifications for a thoroughly modern turbine power plant for the Ambassador.

The equipment specified consists of three 200-hp. non-condensing Westinghouse turbines, each of which drives a 200-kw., 250-v., direct-current Westinghouse generator. Special attention was given to the turbine foundations in order to prevent the vibrations of these high-speed machines from being transmitted to the structure of the hotel. The foundations were to consist of

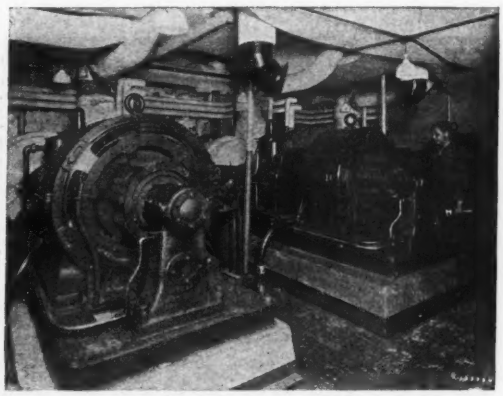


FIG. 1. 200-HP. WESTINGHOUSE TURBINES SUPPORTED ON CORK AND HAIR FELT TO PREVENT TRANSMITTING VIBRATIONS TO HOTEL STRUCTURE

a concrete block which was to rest on a 2-in. bed of sand and was to be separated from the building's foundations by a thick layer of cork on three sides and an open space on the fourth side.

In spite of these precautions, however, the turbines could be heard in many parts of the hotel as soon as they were started up. Puzzled by this apparent failure of their plans, the engineers made a thorough examination of the installation and soon located the trouble. In pouring the concrete block, the cement had leaked out into the cork and the sand, and had formed a solid mass, thus destroying the sound-absorbing cushion that had been prepared. These defective foundations were therefore torn out and new ones were laid. The rock was levelled, brought to an even surface with cement and the four sides enclosed with 8-in. brick walls up to the floor finish, the whole of which was then waterproofed. A 2-in. layer of hair felt was placed on the bed, and a 2-in. layer of compressed cork placed on

top of that. Then came another layer of felt and another of cork, and this same insulation was returned up the face of the brick walls to the floor level. The interior surface was again waterproofed with five-ply membrane felt and pitch, this returned over the top edge of the side wall insulation. Into this insulated water-proof box, a concrete block was carefully poured which extended over the side wall insulation with brass drip strip cast into the foundation.

This new arrangement solved the problem. Even in the grill room, which is directly above the turbines, not a sound from the engine room can be heard.

No Boiler Plant

Another interesting feature of the Ambassador's power plant is the method used to regulate the steam supply. In order to eliminate boilers with their smoke, dirt, and trouble, steam is not made on the premises, but is obtained from the New York Steam Co. It comes in at 160 lb. pressure, passes through the turbines, and is exhausted by them at a pressure of 7 lb. This exhaust steam is used for heating, making hot water, operating the absorption refrigerating machinery, and for various kitchen and laundry purposes.

FIG. 2. SWITCHBOARD SHOWING THE EDISON COMPANY'S PANEL AT LEFT AND GENERATOR PANELS IN THE CENTER

The largest part of the demand for steam is, of course, for heating; and if the turbines were operated with the same load all year round, a large amount of steam would necessarily be wasted during the summer months. To avoid this, a supplementary supply of electric power is obtained from the New York Edison Co.

In winter, therefore, two turbines are regularly in use (with the third as a spare), and these supply all the steam and most of the power required. In summer, however, the exhaust from one turbine furnishes all the steam needed, so the other one is shut down, and a much larger amount of electric power is drawn from the central station. A special switchboard, built by the Westinghouse Co., permits various combinations of circuits to be supplied by either the turbines or central station, in accordance with the demands for steam. In this way, the most economical ratio of purchased steam to purchased electricity can be constantly maintained.

The Man Who Couldn't Come Back

By Robert Hamilton

OUTSIDE the boarding house in "D" location, the wind swept a driving snow before it and the rapidly disappearing fences furnished immutable evidence that the Lake Superior country was in the grasp of another long and hard winter. Old Bill and I had lingered after the others that night to play our weekly game of cribbage, so the cheerlessness of the front parlor and the moaning of the few scattered, tall and gaunt, wind swept pines in the back yard did not exert quite the same depressing effect as usual.

Possibly my friendship with Old Bill had motives which were ulterior behind it, for I was somewhat curious about this old man and meant some day to get from him the story of his life which showed so plainly in his seamed and gaunt features.

Old Bill, the shop foreman had said as he pointed him out to me one day during my first weeks with the company, was a graduate of one of the best eastern technical schools. Here he was puttering around the shop taking care of odds and ends that nobody else wanted to bother with, and muttering to himself as he worked. Further than that, nobody seemed to know much about him although the shop foreman had also said that Old Bill was at one time Chief Master Mechanic of the X company which meant that he had a mighty big job. The way a mining company was organized in the old days, the chief M. M. was the king bee of all the shops, power houses, hoisting engines, and in fact all mechanical equipment.

Yet here he was living the cheerless existence of an old man without money, without friends and with not much to look forward to except possibly a grave in some bleak and snow swept clearing that might be called a cemetery.

Old Bill seemed unusually amiable that evening, possibly because he had just beaten me two out of three games, so, as he pulled out a package of Peerless and took a chew, I decided to risk a personal question.

"Bill they tell me you went to school at ————," I began dubiously, "how did you happen to land up here?"

Startled for a moment, the old man chewed reflectively before he answered. "That's a long story, son, and one that I don't ordinarily talk about, but you've been mighty decent and maybe it might help you over some tight places if I told you."

Getting up from his chair, Old Bill went over and peered out the window where an electric light hung high on a pole feebly lighted the swirling eddies of snow and showed no sign of human life within the range of its sickly rays. I filled my pipe thoughtfully.

"As a youngster," began Old Bill, "I was always more or less of a dreamer and I had a way of tackling a job feverishly while it appealed to my imagination and then I would fiddle away and dream and the first thing you know the folks would begin to say how worthless I was and then I'd start again with a rush and finish the job up in great style.

"My father was probably a misfit, as he had never been successful in the little business he ran but was always tinkering with things and trying to get them patented. Somehow they never worked out successfully,

but Dad always kept on trying and we kept getting poorer and poorer.

"He was a very quiet man and never had much to say to us kids, but it finally came out that he had decided I was to go to ———— University for a technical education. I hadn't thought much about it myself, but I supposed that was as good as anything.

"It was a hard struggle, those four years both to get the money and for me to pass in my studies. Oh, I was bright enough, as far as that goes, but my old failing would come back. I would start out like wild, best man in the class, and then in a few weeks I would be dreaming the days away until about two days before the end of the term I would come to with the knowledge that I wouldn't pass unless I made a superhuman effort.

"As a matter of fact, I always did get through and better than the average, but I did it only by getting such a high standing on my examinations that the instructors figured they had under-rated me in the class rooms. They never knew at what cost those grades were made; what days and nights of study I had to put in at the last minute, to come back.

"Well, after I finished I got a job with an engine builder on erecting jobs. It was just as it had been at school. I always got the jobs finished on time, but it was at a high energy cost at the last minute. Once I nearly got caught; but it finally turned my way, so everything was all right.

"From this engine builder I went with a structural steel company and my job was putting up bridges. It was a good job and I set the world on fire for a couple of years. About the time I was beginning to lose interest, they brought me into the plant and put me in charge of fabricating and production."

Old Bill moved a little uneasily and I lighted my pipe, which had grown cold, and leaned forward as the old man continued:

"Well, they fired me, kicked me out finally; said I was all right when I was all right, but there was too much between times. That didn't bother me much; I was still young. Finally I landed the job as master mechanic with the X Company. Of course the X Company wasn't as big then, still it was a pretty fair job.

"When I began with them, I started big; started a lot of things they had never heard of; got a lot more efficiency out of the plant, cut down the coal consumption and fixed up the whole outfit. It was mighty interesting work and I had everybody with me clear down to the coal passers.

"Two or three years went by and somehow things didn't seem to go as well: the management noticed it and called me in for a friendly talk. Well, I straightened her out again; but it seemed that I didn't take as much interest in getting around as I used to and even the spur by the management didn't seem to awaken the old comeback spirit.

"One day a boiler at one of the compressor houses let go, killing a couple of firemen and a coal passer. When that happened, I had to step lively for my job; but I finally got by and for two or three years the memory of that boiler put new life in me. But I began to drift again and when a hoisting cable let go and dropped eight men a couple of thousand feet, I found myself out on the street once more."

The old man paused and filled his pipe. "You see," he continued, "I had depended too much on my ability to come back at the last minute. My whole life had been a series of incidents where I had come off victorious at the last minute. That's all right in a way; it's a good thing to be able to tie into a job and get it finished regardless of difficulties; but the trouble is that after your boiler has blown up, or after your hoisting cable has busted, it's a little bit late to start the drive to put things shipshape.

"My boy, keep pluggin' away. Don't worry about the brilliant spurts. They may get you in the limelight, but they won't keep you there. Fellows that I used to think were dubs years ago have good jobs now, homes of their own and are well thought of in the places where they live. They got there by everlastingly keeping at it.

"As for me,—well, I suppose I had ambition once, but it wasn't backed up by enough will power. I was either going like a house afire or else I was on the edge of disaster. When the crash came, I went down and somehow I was never able to get back up."

The room had grown cold. Outside the pines still moaned and the wind-drifted snow piled high. Inside, Old Bill and I sat meditating.

Waterproofing Materials

BITUMEN, another name for asphalt, was known before Noah; it is stated that Noah used bitumen to make the ark waterproof. Borrowing from an article by Joseph K. Costello, in the April issue of Building Materials, we get:

"Asphalt, varying in chemical nature to a slight degree, and known by various trade terms, is mined in different parts of the United States. Each of these varieties has a particular adaptability to some use. Gilsonite is used in the manufacture of paint, japans, varnish, waterproofing and in electrical insulating materials; refined wurtzilite is used principally in the manufacture of insulating composition, marine and iron paints, acid-resisting compounds and other protective coatings, including prepared flooring. Grahamite is used for roofing, flooring, varnish and for brick and stone filler. Gilsonite, another asphaltic compound when combined with rubber and vulcanized makes it better able to resist extreme temperature changes. Ozokerite is used in the manufacture of leather polish, sealing wax, electrotypers' wax, candles, electric insulators, carbon paper, and ink."

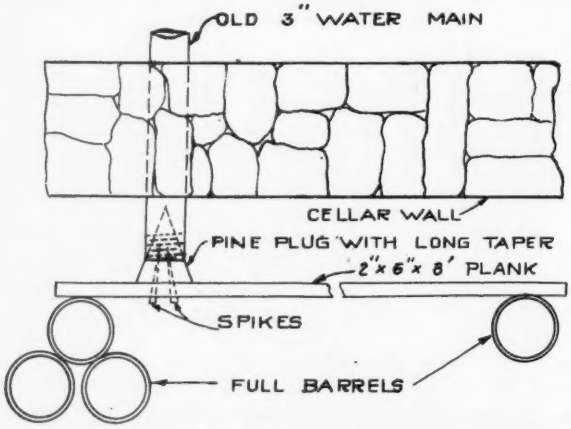
"With it Hannibal concocted his famous 'Grecian Fire.' It was the paint that covered the walls of ancient Babylon Xenophon used it for a mortar and Cleopatra used it to strengthen her vampish eyebrows."

All of which reminds us that there is nothing new under the sun.

FOSTER HALL, the million dollar chemical laboratory of the University of Buffalo, designed especially to meet the needs of the electro-chemical, hydroelectric dye and steel industries on the Niagara Frontier, was dedicated on Oct. 27. Dr. Edgar F. Smith, president of the American Chemical Society, and Dr. Edwin E. Slosson, of Science Service, were speakers at the ceremony, which included the installation of Dr. Samuel P. Capen, of Washington, as chancellor of the university.

Stopping a Flood

FROM AN OLD building, 60 by 225 ft., originally a sugar refinery, and now occupied as a storage warehouse, adjoined a large manufacturing building in New York city electricity was supplied to the elevators in the warehouse. The cellar floor sloped about 1 foot in 100, from end to end. Near the high end of the cellar, an old 3-in. water main came through the building wall from the street, with a gate valve, nipple, ell, and a short length of pipe. This pipe nearly covered with rubbish has been there so many



SOME BARRELS WERE UP-ENDED TO SERVE AS A FULCRUM FOR THE PLANK LEVER

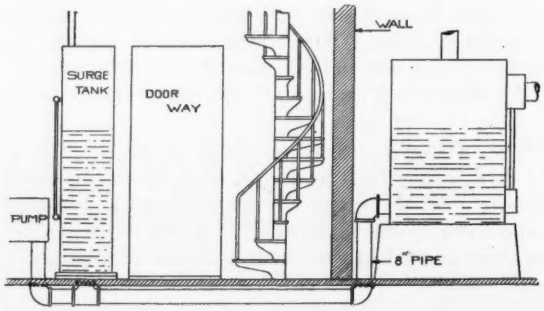
years, that none of the present occupants knew it was there. One morning, the warehouse foreman complained that the floor in that end of the cellar was wet, and upon removing the rubbish, the pipe was found to be dripping. Accordingly, a man was sent to remove the pipe, and plug the valve. At the first pull of the wrench, the valve dropped off the end of the main, and the rush of water nearly took the man off his feet. No shutoff valve could be found outside the building. The water department was notified, and we were informed that the water could not be shut off in that street until 12 o'clock that night. As there was no suitable lumber on hand from which to make a plug, two pieces of 2-in. planks were nailed together and hastily hewed out, but this plug could not be entered against the pressure of 30 lb, neither was there anything to brace against, even if it could have been entered. In the meantime, goods stored in the lower end of the cellar, that were buoyant enough to float, were floating. Luckily, three of the four elevators were of the overhead construction; but the motor for the fourth was on the cellar floor, in a brick room, the door sill of which was 12-in. high but the water was soon cascading over this into the motor-room.

A 2-in. steam syphon was available, and was installed in the motor room, and piped up in a hurry. The party wall between the buildings, was of stone, and 3 ft. thick, but a 1¼-in. steam pipe was crowded through the opening along with the conduit pipes, and soon a 2-in. stream of water was being discharged into the street. While this was being done, a piece of 4 by 4-in. white pine was procured from a nearby lumber yard, dressed to a long tapering point, and nailed to a 2 by 6-in. plank. Some barrels were rolled in position, and up-ended to serve as a fulcrum for the plank as shown in the accompanying figure. It was easy, then, to enter the plug, and by pushing the plank in, the water was completely stopped. Another barrel at the end of the lever, kept the plug in place until the water was shut off, and the pipe removed.

M. M. BROWN.

Surge Pipe Solves Suction Problem

THE WRITER recently visited a plant where he saw an unusual feed pump arrangement. The feed heater equipment was installed in the engine room, taking the exhaust steam from the generators. The feed pump, however, was installed in the adjoining boiler room,



DIP IN HOT WATER SUCTION PIPE WHICH CAUSED KNOCKING

along the wall before the boiler fronts, the pump being located perhaps 40 ft. from the heater. In the corner of the boiler room next to the engine room was a spiral stairway, and also a doorway to the yard, with the result that the hot water line to pump had to be carried below the floor, as shown in the sketch.

Upon starting up the outfit, considerable trouble was encountered with knocking and pounding in the pump, due, it was decided, to the lack of a sufficient head of hot water on the pump valves, the friction loss in the piping being responsible for some of this loss of head. The heater could not be raised, nor the pump lowered, and the operators were about to put in a 10-in. line to

replace the 8-in., when someone in the plant suggested they install the surge pipe arrangement shown in sketch, which consisted of a length of 12-in. pipe set into the suction line near the pump, and vented to atmosphere, the idea being that this surge pipe would carry a supplementary supply of hot water right at the pump which would take care of the fluctuations in the demands of the pump. The recommendation was followed and the installation made as shown and the operators now report highly satisfactory service in every way. This represents quite a nice solution for this problem which is quite commonly encountered in ordinary power plant work, and in this particular case saved the expense of tearing out an 8-in. line and replacing it with a 10-in., while at the same time insuring, perhaps, better results than would have been obtained with the larger pipe.

M. A. Saller.

Care of Commutators

I have followed with interest the recent discussions concerning the care of commutators and therefore venture to recount my own experience on the subject as gathered in the shops of two of the leading manufacturers of electrical apparatus.

While attending turbine schools at the General Electric Co. and The Westinghouse Electric and Manufacturing Co., I was, among other things, schooled on the care of commutators. The method adopted for putting a commutator in shape at these shops is first to swing the armature in a lathe, or, if practicable, to remove the brushes, leaving the armature in its bearings. The commutator is now turned down by running it at normal speed and, finally it is trued up by grinding with a special stone, running the armature at a high speed.

When turning down, the commutator should not be run above normal speed, otherwise the speed would be too great for the lathe tool, which would heat and tear the copper bars.

If mica is the cause of sparking, this mica should be removed by undercutting to a depth of 1/64-in. with a hack saw blade set in a wood block.

Under no circumstances should any lubricant be put on the commutator; if sparking is caused by shooting across bars, the slots should be cleaned out.

Another important thing to be considered in the proper upkeep of commutators is the brush pressure. This should not be less than 2 lb. per sq. in. nor more than 4 lb. per sq. in.

To fit the brushes to the commutator, that is to the same circle, use sandpaper under the brush, sand side to the brush, and pull in the same direction as the normal direction of the armature rotation. Remove the sandpaper when the end of the sheet is reached and repeat until the brush fits to a spotting fit.

Use no rocks, sandpaper, nor lubricant upon the commutator at any time.

James M. Bolar.

Unusual Methods of Alining Pulleys

Recently we installed a motor driven compressor set where we were compelled to employ a rather unusual method of alining up the motor and compressor pulleys. The motor pulley was made of paper and, due to the fact that it had inadvertently been left out-of-doors in all sorts of weather, the edges had become so ragged that it was impossible to line from the edge of the pulley in the ordinary way.

As an alternative, we rigged up two 2 by 4 uprights as shown in the accompanying sketch, and made a saw cut in each at such a height that a line between the two passed approximately through the center lines of the shafts on both the motor and the compressor. The distances A and B on the compressor wheel were calipered and adjusted by moving the line along the horizontal saw cut. Then we obtained a line parallel to the wheel and at a distance, X, from the crown. Next we affixed to the motor pulley a ¾ by 1-in. stick, in the end of which was driven a nail with the head at a distance, X, from the crown of the pulley.

We then adjusted the position of the motor so that with the stick in position C, the head of the nail just cleared the line. By turning the shaft through a half revolution, the nail was brought into position D and

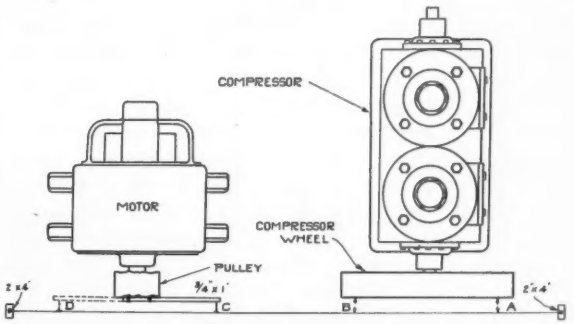


DIAGRAM OF SYSTEM USED FOR ALINING PULLEYS

the motor base was again shifted to bring the head of the nail just clear of the line.

Thus by shifting the motor until the nail just cleared in both positions, we got the motor pulley parallel and in line with the compressor wheel.

August Gass.

Reduction Fittings Are an Improvement on the Ordinary Bushing

It often happens, when we have a piping job, either repairs, renewals, or a new installation, that we find ourselves handicapped by a lack of the proper reducing fittings. Anyone who has had any experience with pipe work and fittings knows that the usual bushings are the fitter's bugbear, as there is always danger of breakage, usually after pressure is turned on, but often when making up. This is especially true of bushings which reduce one size, for example, 1½ to 2-in. In making up small pipe work 2½-in. and less, I always resort to the use of sleeve couplings as bushings, using a heavy coupling of desired size and cutting a thread on the outside at one end. This makes an admirable bush, is quite readily made up or disconnected and takes but little time to make; it also has a pleasing appearance.

Regular bushings are usually threaded rather full and must be reduced so as to enter the fittings which are in turn not always properly tapped. As we all know, when a bushing does not enter a fitting properly, with half of the thread projecting, the danger of breakage is

doubly increased. Making the bushings as described really takes less time than working over the regular type. Where, however, the reduction in size of pipe is more than one size, the usual bushings will usually be found amply strong if well entered in the fitting. At best, though, bushings are but a poor substitute for reducing fittings.

CHAS. L. RIECKE.

Locating a Boiler Compound Feeder

IN A POWER PLANT where a direct return tilting trap was installed for feeding the boiler in place of pumps, when all the pipes were connected they found that it was impossible to locate the boiler compound feeder so it could be connected into the horizontal feed line as it was when the pump was in use. This was due to the

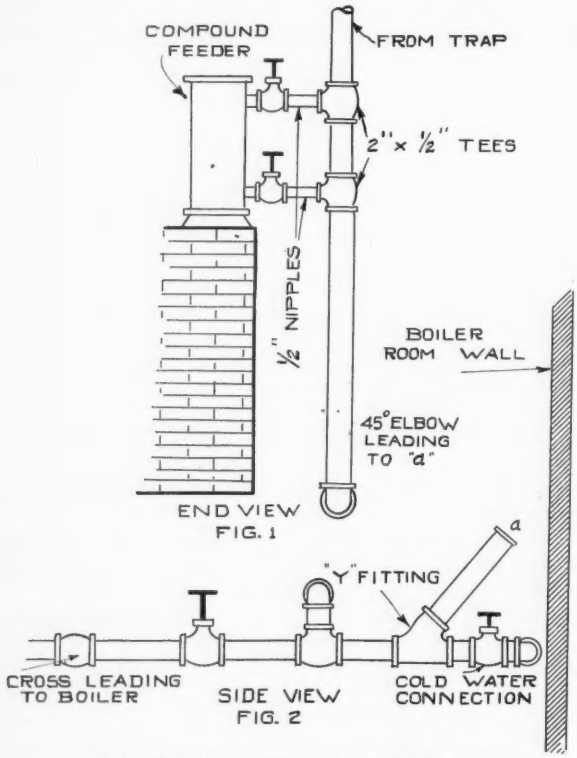


FIG. 1. COMPOUND FEEDER ON VERTICAL PIPE
FIG. 2. FITTINGS IN HORIZONTAL FEED PIPE

fact there was not sufficient space to place two tees in the horizontal line to cement the inlet and outlet pipes of the feeder.

To get out of the difficulty, it was decided to locate the compound feeder on top of one of the boiler side walls near the vertical pipe of the trap discharge, as shown in Fig. 1. By placing two tees into the vertical pipe and connecting the compound feeder as shown, it did the work as well as if it had been connected into the horizontal pipe as it was formerly.

The reason there was not the room in the horizontal feed pipe as shown in Fig. 2 was due to the fact that after making all the changes in the pipes when installing the trap the fittings needed, such as nipples, check, and globe valve and Y fittings, into which the vertical pipe from the trap connects as well as the cold water connection from the water meter, took up all the space between the crossleading to the boiler, and boiler room wall, as illustrated.

H. A. JAHNKE.

Condenser Pump Refuses to Function

COMING ON shift one morning, I noticed that the log book showed that No. 1 condenser pump, which is used in connection with a barometric condenser, would not pick up its water.

This pump had been repaired and a new discharge deck put on with valves and springs complete about two weeks before. and had been working well. When the chief came in he noted that the gage on the discharge valves were fairly tight.

We took the head off the water end, and found it in good condition; we examined the suction pipe to the cold well, and found no leaks, but still she refused to pick up water. Someone said that there was too much pressure on the discharge valves, but that idea was scouted by the chief. The suction deck was gone over carefully, but with no better results.

After dinner the chief tried the pump again and got water, but a short time later the condenser was wanted so the pump was tried again, but this time it would not pick up. As a last resort, we opened up a drain on the discharge line and when the pressure was nearly all off we started the pump and got water right away.

Apparently the head of water on discharge deck was greater than 14.7 lb.; consequently the pump could not rid itself of air.

Now, on shutting down the pump we drain the riser, which otherwise was done only in cold weather, to prevent freezing.

Previous to the time when the new valves were put in, the leakage through the discharge valves had allowed the pressure on the riser to drop enough to allow the pump to pick up its water.

M. W. C.

Repairing Furnace Door Catch

I USED TO HAVE trouble with my boiler furnace doors opening partly by themselves because the door catches at the bottom of the furnace door opening were worn

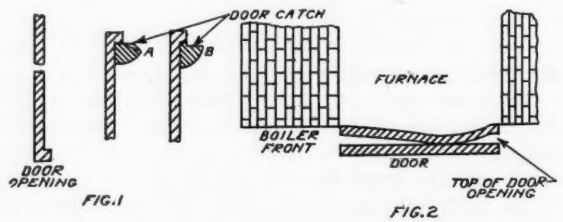


FIG. 1. WORN FIRE-DOOR CATCH AND REMEDY
FIG. 2. WARPED FIRE-DOOR FRAME

badly, as shown in Fig. 1 at A, so that there was no longer a hold for the doors. Frequently one of the doors would open when I was in the engine room and much cold air would rush into the boiler furnace. To remedy this trouble, I cut the door catches to the shape shown

at B; this would not allow the doors to open themselves as the new shape of the door catch surface prevented it.

Frequently we find boiler furnace doors having no tight fit where they come in contact with the door opening, especially where the doors have seen long service and the holes in the door hinges and the pins are badly worn. I have remedied trouble of this kind by reaming out the hinge holes so that they were round again and large enough to fit the next larger size pin.

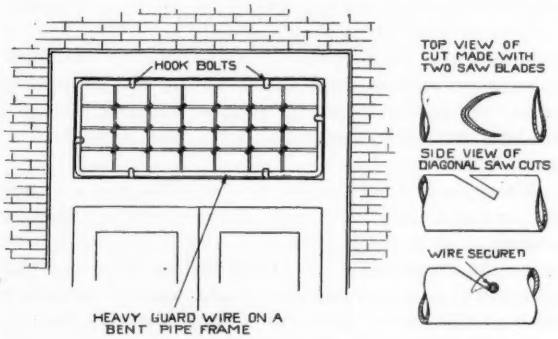
Then again we find in some plants that boiler fronts are warped badly at the furnace door opening as shown in Fig. 2, which is exaggerated to make the condition plain. I have remedied trouble of this kind by grinding down the high surface of the door opening with a portable emery wheel driven by an electric motor. When an attempt is made to straighten this surface with a hammer and chisel the front surface lining is jarred loose unless the work is done when the old furnace lining is torn out for removal. JAMES A. HOLT.

Method of Fastening Guard Screen to Frame Preventing Spring of Small Shafting in Lathe

WE HAD occasion to construct a heavy screen guard for a transom, and in making this up hit upon a novel but substantial means of securing the guard wire to the tubular pipe frame which was used in this guard.

After bending the frame to the desired shape, the heavy screen was placed above it and the position of each wire marked with a piece of chalk.

With two saw blades to obtain width of cut, diagonal slots were made, one-third the way through the frame. The guard wire was set into these slots and the overhanging lips were driven down firmly over the wire,

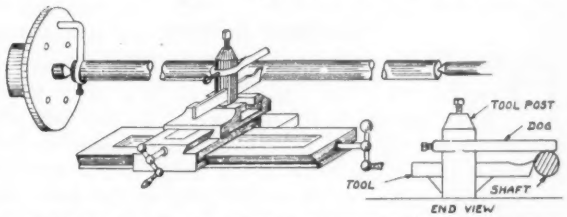

HOOK BOLTS
HEAVY GUARD WIRE ON A BENT PIPE FRAME
TOP VIEW OF CUT MADE WITH TWO SAW BLADES
SIDE VIEW OF DIAGONAL SAW CUTS
WIRE SECURED

GUARD SCREEN AND DETAILS OF FRAME

with the end of a punch. These lips doubled down tight against the wire, crimping it slightly and making it very secure. The frame was held from the inside, with hook bolts for purpose of removal.

Brass rod or small shafting, while being turned in the lathe, will spring away from the tool, making a ragged job of the cutting and change in diameter due to this springing, so that the cutting of a uniform size is almost impossible without some form of support or rest to the work.

In the accompanying sketch, a method of using an ordinary straight end lathe dog, is illustrated, which is advantageous and a simple adaption, to use this for prevention of the shaft or rod springing away from the cutting tool. In description of the illustration, the cut is started and where the diameter is determined, the lathe is stopped, and the dog is placed over the tool post, above the tool. Tightening the set screw holds the end



USE OF DOG AS STEADY REST FOR TURNING WITH LATHE

of the dog a fixed distance above the tool, and springing of the part being turned is prevented by the dog serving as a rest and preventing any upward movement.

G. A. LUERS.

Weighing Ice Without Scales

THE ARTICLE, "The Weight of Ice without Scales," by J. B. Dillon, on page 950 of your Oct. 1 issue, reminds me of a little kink that I used for figuring tons of ice from blocks of ice, that some of your readers may not know.

If the blocks weigh 50, 100, 200, 400, or 500 lb., it is a simple matter to find out how many tons a given number of blocks amount to by dividing the number by 40, 20, 10, 5, or 4 respectively; but if they weigh 300 lb. as they happen to in the plant where I work, and in many other plants, it takes a little more time and paper to divide the number of blocks by 6⅔ or to multiply it by 300 and then divide by 2000, than it does in the above cases. I use the following method that I happened to run across somewhere: Point off one place on the right of the number of blocks, divide this number by 2, and add the result to the number of blocks with the one place pointed off. The result is the number of tons that that number of blocks amount to.

For example; suppose we have 11,468 blocks:

$1146.8 \div .2 = 573.4 \quad . \quad 573.4 + 1146.8 = 1720.2\text{T}.$

W. M. MILTON.

Value of Engineering Records

ENGINEERING RECORDS cover all matters concerning work done by the engineering department, if there is one, or similar work done by outside firms; so that there is a complete, concise, comparable history of the additions, alterations and repairs on each engineering equipment piece.

These are valuable, as

1. Giving a bird's-eye view of the physical condition of the equipment.
2. Facilitating the making of the physical inventory.
3. Assisting cost calculation.

ROBERT GRIMSHAW.

Pipe Fitter's Compound

AN EXCELLENT compound for application to the threads of pipe joints may be made by mixing equal parts of boiled linseed oil and Portland cement. This cement has the quality of making a tight joint and at the same time, enabling it to be taken apart easily.

C. C. BROWN.

Repairs to Loose Piston on a 2500-Hp. Engine

By Charles N. Shaw

ONE morning on making my rounds of the several engines of which I had charge, in a large textile plant, the operating engineer of the 2500-hp. unit called my attention to a peculiar intermittent clicking noise that was apparently in the crank end of the low-pressure cylinder, which sound to us as the noise that would be made had the gland nuts of the stuffing-box worked loose and allowed the metallic packing case to work slightly at times. After listening carefully for a time, we about made up our mind that that was the trouble, and if it did not get any worse we would let it go until we shut down at noon and then tighten it. Just then, however, as we passed the head end of the cylinder a most terrific thump occurred in the cylinder that fairly made the floor tremble.

Only one thump took place, and while we were wondering what next would happen and debating as to what it could be it occurred again. As the mill was running on government work, and was being pushed for production, I did not wish to shut down for an examination if I could possibly avoid it; however, I called up the production manager and asked him to come to the engine room, telling him that we might have to shut down. As he was entering the engine room the thump came once more, the elapsed time between the first and last thump being probably 15 min. While talking over the matter of shutting down for an examination, the superintendent of machinery (having charge of all machinery in all the mills) happened in. He was told what we thought was the matter, but laughed at the idea of the head being loose on the rod, as a new rod had been fitted to the head some time before and had been made a press fit, and as he had seen the rod pressed in at a pressure of from 20 to 30 T. per sq. in. on an 8-in. ram, he just knew that the rod was not loose.

We had been talking possibly a half hour and as no further noise came from the engine decided that things were all right. Just as we were going out the door the thumping began again and continued to thump until the steam was shut at the throttle; it was then agreed to shut down and make an examination, but to get going if possible by 1:00 p. m.

The cylinder head was then removed and the holding nut was found to be as tight as a box wrench and a 16-lb. sledge could make it, and I was laughed at for suggesting that such a thing as a loose head could be; nevertheless I contended that the trouble was what I had said, and as the superintendent of machinery could offer nothing that would cause the trouble we took down the main rod on the low pressure side and got ready to run the engine high pressure condensing, and by that means run about ⅔ of the mill until repairs could be made.

We then removed the piston and rod, the piston being 64 in. diameter, the rod 6⅞ in. diameter, and 10 ft. 2 in. long, weighing in all something like 8000 lb., and removed it to the yard (the engine room floor being some 15 ft. above the ground), where we could work on it without spoiling the engine room floor, which was of polished maple.

After the piston and rod was removed from the cylinder I noticed that the head was not up to the shoulder on the rod by more than 1/16 in., but why the holding nut had not pulled it home I could not imagine; however, I was now sure that the head was loose on the rod. Getting the piston into the yard took us well into the night, when we knocked off for some sleep, and as my duties required me to be at the mill at 5:00 a. m. and being afraid of oversleeping if I went home, I lay down in the engine room with instructions to the watchman to wake me at his five o'clock round.

After getting things going, I set to work to remove the nut from the end of the rod, and then found why the nut wouldn't draw the head up to the shoulder, the thread not being cut back far enough on the rod letting the nut bottom and not draw at all. I then instructed the men what to do in preparing to remove the rod from the head, and went to breakfast. Upon my return, I found the superintendent of machinery and the boys trying to ram the rod out of the head with a 6 by 8 oak railroad tie. Not being able to remove it, he was very strong in his language about a man who considered that head loose on the rod; I said nothing to him, however, but sent some of the boys to get a tripod derrick we had, and some more to get a piece of 2-15/16-in. shaft about 14 ft. long that was in the stock rack, as well as a pair of rope falls. These were brought and the tripod set up and the shaft hung with the rope falls where we could get a good swing at the end of the rod, and with one bump we knocked the rod out of the fit the whole length (14 in.), just catching in the bore by the thread end. I then asked the superintendent of machinery if he then thought the rod was loose, and he remarked that as I was so smart I could go ahead and make my own repairs as he had to go to one of the other mills.

Now, repairs such as this were not up to me to make, as the superintendent was supposed to supervise them, so I informed him that he would stay where he was and make the required repairs, or I would call up the main office and lay the matter before the general manager, and as I had done more than I ought to have done, I went about my other duties.

About noon I was called to the office and was told that the engine builders wanted the head and rod shipped to them so as to fit the new rod, also to get the fit and eye on the crosshead end. I was further informed that we would run the engine each night until 10 o'clock to make up the loss of production, as the engine builders wanted four weeks to do the job.

I inquired why the job was not done there by their own crew and save all that time and unnecessary expense, and was told that there was no way of fixing the engine without a new rod, and they thought it was better to let the engine builders do it than to attempt to make a new rod themselves.

I then stated that the job could be done by their own men and a permanent job made, and the engine running in 48 hr., and was told that if I could do the job to go ahead and do it, so this is what we did:

The rod was turned down on the head fit ¼ in. smaller than it was, and then taken to the welding shop and built up around, with the torch sufficiently large enough as to allow enough metal to turn to a sure fit. The bore in the head was found to be about 0.003 taper in 14 in. (this was where the slip had been made on the old fit, as it was

turned straight, and was not very snug at the small end). The building up of the rod took 19 hr. and it was left to cool until water dropped on it would just steam a little. It was then cooled and taken to the lathe where a shrink fit was made, allowing 0.007 in. larger than the small end of the bore. Also a gage had been made of cast iron 1 in. thick and 0.001 in. larger than the fit on the rod, which made it 0.008 in. larger than the bore at the small end. In the meanwhile, the head (which was of cast steel) was placed on fire bricks and a fire placed under it ready for lighting, and the tripod placed over it so as to handle the rod. When the rod was finished and hung with a pair of chain falls exactly over the bore of the head, the end of the rod was pulled away from the fire with a rope and tied out of the way of the heat and the fire lighted. One hour and 20 min. after starting the fire, the gage entered the large end of the bore, and 20 min. after the gage passed through the bore, the rod was then swung into place and was lowered into position as nice as anything you ever saw. The fire was then quenched and the work allowed to cool during the night.

The following day the parts were assembled and that night the rod was connected up and the engine tried out and everything proved all O. K. The time on the repairs after getting started was 41 hr., including time lost in cooling. Some time after the job had been completed the managing director came to the plant and made the remark that the job of repairs on the engine had saved them a world of money and that the superintendent of machinery was to be congratulated, as he was the right man in the right place, and showed great knowledge in such an emergncy, as the old saying goes, "The greatest ass gets the most oats." Selah.

Leveling with a Hose Full of Water

By W. F. Schaphorst

NOT long ago, I wrote an article describing a method of leveling by simply filling a hose full of water. Then by means of gage glasses inserted into each end of the hose the exact level can be readily noted. This is an exceedingly good method for leveling shafting, foundations, floors, beams, etc.

I am in receipt of a communication from a Californian who criticizes the method. He says he found it very hard to do. It occurs to me that my reply, which follows, may be of some value.

"I had a similar experience at first, but I found that the best way to handle the hose is to keep one end fixed and to simply move the free end around. It is true that the job is a difficult one for one man, although I have done it alone; however, I did not have any difficulty in getting the same results twice and cannot understand at this distance why my correspondent should have difficulty in that respect. It may be, however, that air got into the hose, in which case a difference of levels would register, or if there should happen to be a residue of oil or some other liquid in the hose the specific gravity of which might be less than the specific gravity of water such things would also influence the level and would make it absolutely impossible to do an accurate job with this kind of a level. Also, now that the subject has been brought up, it occurs to me that a difference in temperature at one end would also influence the level, but I believe such great differences in temperature seldom exist; however, if one end should be kept for any length of time near a radiator or near a steam boiler, there would be considerable danger of differences in levels and the results certainly would not be reliable.

"The method of corking up the ends while moving the hose is all right, also the method of using valves instead of corks is all right; but during the leveling or after arriving at a point that is almost level, the corks should be removed or the valves should be opened so that there will be no air pressure above the water level. The air pressure would, of course, tend to throw the water out of level."

Installed Capacity and Power Output in 1922

TWO interesting sets of figures compiled recently by the U. S. Geological Survey are shown herewith. The first set shows the capacity of installed prime movers in the United States in 1922, while the second set gives the annual output of power in 1922.

CAPACITY OF INSTALLED PRIME MOVERS IN U. S. IN 1922
(THOUSANDS OF HP.)

Industry—	Steam engines and turbines	Water wheels	Internal combustion engines	Total
Public utilities	16,150	6,500	350	23,000
Manufactures	17,750	1,750	1,400	20,900
Mines and quarries	3,700	40	1,660	5,400
Locomotives	65,000	....	....	65,000
Total	102,600	8,290	3,410	114,300

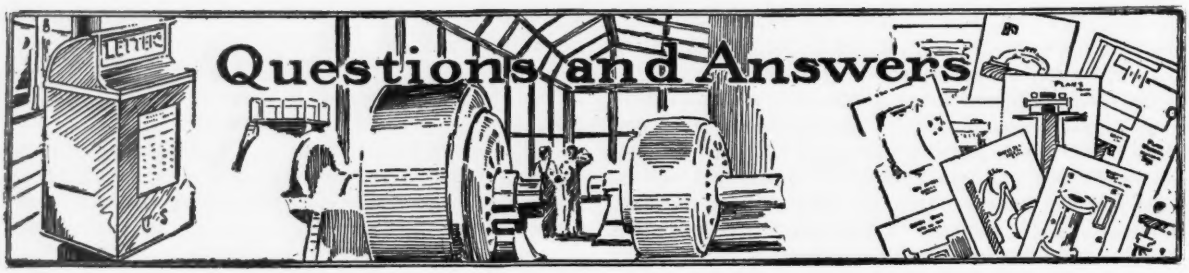
The foregoing figures are based on the census of electrical industries in 1917; the census of manufacture in 1919; the census of mines and quarries, 1919; and the 34th annual report on the statistics of railroads for the United States. Curves were drawn based on the data given for certain years, as given in the above reports, and by the Geological Survey for water power and capacity of steam engines and turbines in public utility plants. The curves were extended to 1922.

ANNUAL OUTPUT OF POWER IN U. S. IN 1922
(MILLIONS OF HP.-HR.)

Industry—	Steam turbines, and int. combustion engines	Water wheels	Total
Public utilities	40,000	23,000	63,000
Manufactures	33,300	3,050	36,350
Locomotives	40,000	....	40,000
Total	113,300	26,050	139,350

These figures are based on records of public utility output for January-August, 1922. Manufactures and locomotives prorated from estimates for 1919 in Flood's letter of Nov. 1, 1920.

WHAT was probably the most remarkable train of locomotives ever hauled across the country was recently shipped from the Baldwin Locomotive Works, to the Southern Pacific Railway system. The shipment was part of an order of 50, and consisted of 20 locomotives each 100 ft. in length and each weighing 621,000 lb.



Cylinder Lubrication

I WOULD LIKE to have some of the readers of these columns who are acquainted with both marine and stationary practice tell me why, on large engines, the stationary engineer uses a lubricator with heavy cylinder oil while the marine engineer does not.

C. A. T.

What Causes Water Hammer in the Boiler Feed Line?

I HAVE a 6 by 4 by 6-in. boiler feed pump, 3-in. suction, 2½-in. discharge, feeding three boilers. Each boiler takes off from the 2½-in. pipe through a 1½-in. line. If I run the pump up to speed, it causes a water hammer in the 2½-in. line; but if it runs slow, there is no hammering. I have tried all kinds of valves with no success. Ordinarily I run only two boilers at a time. If you can suggest anything that I can do to overcome this trouble, I shall appreciate it. W. S. S.

Apportioning Costs Between Power and Heat

HOW SHOULD I arrive at a figure showing the cost of heating a two-story and basement brick building with exhaust steam? For six days of the week of 24 hr. each. I use engine exhaust and on Sundays and holidays, reduced live steam.

When I heat with live steam I use 1500 gal. of oil, at 4½ cents per gal., with an outside temperature of 10 deg. and an inside temperature of 70 deg. F. When I heat with exhaust steam, I use from 1800 to 2000 gal., depending on the power load that is being carried, the steam pressure is 100 lb. reduced to 2 lb.; the back pressure on the engine is also 2 lb.

L. B.

Pop Safety Valve Refuses to Pop

WE HAVE here four 333-hp. vertical water tube boilers, each having two, 4-in. pop safety valves. I have trouble in getting them to operate properly. They simmer all the time when the pressure gets about 5 lb. below what they are set for. We carry 145 lb. gage, and some of them blow back anywhere from 10 to 30 lb. I would like to know what is the cause of this, and also what I can do to overcome the trouble. Each one has a 4-in. pipe through the roof to open air, about 10 ft. long.

About two weeks ago, we put in a new feed water header of 4-in. extra heavy pipe and fittings. The straight run is about 20 ft. We cut it about ¼-in. short when cold, so that there would not be so much strain on the fittings when hot. The feed water temperature is about 200 deg. F. Is that good practice or not?

Centrifugal Tension in Belting

REFERRING TO the comment by M. B. Cutshaw in the Oct. 1 number of Power Plant Engineering, page 971, under the above caption Centrifugal Tension in Belting, there is no question but that we still have much to learn about power transmission through belting

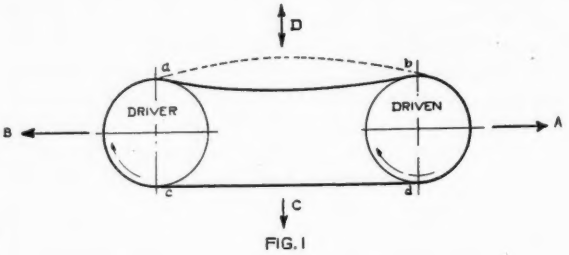


FIG. 1

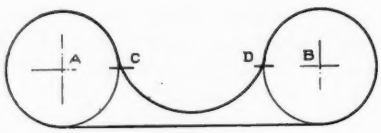


FIG. 2

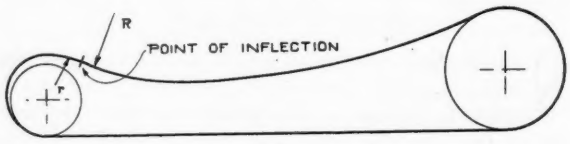


FIG. 3

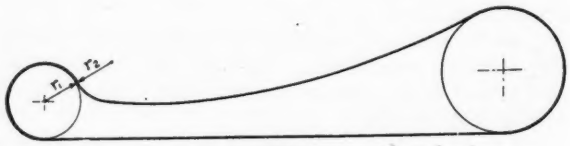


FIG. 4

FIG. 1. FORCES C AND D TEND TO COUNTERACT FORCES A AND B

FIG. 2. PULLEYS CLOSE TOGETHER WITH EXTREME SLACK IN BELT

FIG. 3. CENTRIFUGAL FORCE HAS A TENDENCY TO CAUSE THE BELT TO LIFT AT THE POINT INDICATED

FIG. 4. IN ACTUAL PRACTICE THE BELT HUGS THE SMALL PULLEY AT THE POINT OF INFLECTION OF CURVATURE OF THE BELT

and the behavior of belts on pulleys, particularly on high speed pulleys. Everything is not yet known.

The writer first became interested in belts over 10 yr. ago when he observed that belt theory and belt practice "do not jibe," and he prepared an article on

the subject which was published in Power Plant Engineering on March 15, 1921. This article has apparently been the cause of this subsequent discussion.

It was not I who first discovered that the stress in a belt due to centrifugal tension is the same all around the belt, between the pulleys as well as on the pulleys. I read it at least 10 yr. ago in a text-book written either by Unwin or Rankine and those books had then been in print a great many years. It is not difficult to prove mathematically that the theory is correct. In view of this fact, therefore, Mr. Cutshaw should have drawn arrows vertically as well as horizontally on the diagram accompanying his comment. These vertical forces would have a tendency to counteract the forces A and B. There is no question but that force C, Fig. 1, would always act downward. Force D would act downward when the belt is slack and upward when the belt assumes the dotted position indicated by Mr. Cutshaw. Whether or not the slack side of an ordinary horizontal drive would ever assume such a position or an approach to such a position, I do not know. I do know that some expert rope jugglers can make a loop of a lariat assume nearly a circular form in mid-air, the plane being either vertical or horizontal, the only support being the radial rope leading to the circle from the hand. However, simply because a rope will assume a circular form in a vertical position under circumstances like this is no proof that a belt on a horizontal drive will do likewise. The lariat is not restricted to a definite path whereas the belt is more or less restricted, especially around the pulleys. Besides, the speed of the lariat is slow as compared with the average belt speed. Yet, belts do not, in practice, assume circular shapes in mid-air.

According to the accepted belt theory as I have figured it out, if we should have a drive as shown in Fig. 2, with pulleys A and B close together and the belt slack so that the radius of the slack belt would be less than the radius of either pulley, A or B, the centrifugal force on every particle of belt between the pulleys would be greater than the centrifugal force on any other particle in contact with pulleys A and B, in which event centrifugal force would have a tendency to wrap the belt more tightly around the pulleys and it would not have a tendency to assume a convex upward position as indicated by the dotted line in Fig. 1. The reason for this I attempted to show mathematically in the Sept. 1 number of Power Plant Engineering.

It is true, according to the centrifugal force formula, that where we have a small pulley as shown in Fig. 3 and a considerable distance between the pulleys, the centrifugal force has a tendency to cause the belt to lift at the point indicated by the arrow, the centrifugal force at that point being $WV^2 \div g\,r$. That force is counteracted by the weight of the belt and by the counter centrifugal force $WV^2 \div g\,R$, so that we invariably have a point of inflection close to the small pulley, if not directly on the small pulley as I have indicated. In all of my experience with belting, I have never seen a belt lift at this point unless it could be attributed to pulley vibration, flapping of the belt, air pockets forming between the belt and pulley, or some such common cause. In fact, my experience has been the reverse, namely that when pulley A, Fig. 4, is the driving pulley, and the direction of motion is as indicated by the arrow, and we have a slack running belt, a curve of comparatively short radius, r_2, will form close to the small pulley. Sometimes it appears that the radius of this curve is actually less than the radius of the small pulley, in which case the centrifugal effect of the belt around the small pulley would be entirely neutralized on the ongoing side. This effect is counterbalanced, of course, as r_2 becomes equal to or less than r_1.

Professor Goodman's illustration shown in the September issue, appeared to me to be particularly valuable in this connection because his India rubber belt, when running at extremely high speed, shows no tendency to leave the upper pulley. Centrifugal force appears to have no effect other than merely to stretch the belt. Upon stretching sufficiently, it lost contact entirely with the small bottom pulley and as a result the bottom pulley stopped.

It may be that the curve of this stretched India rubber belt moving at high velocity just happens to fall along the line of a naturally hung cord or chain, nevertheless, here we have an actual photograph which tends to support my contention on the actions of slack horizontal drives. I have no doubt that the curve is not a true catenary, nor a true parabola, and it certainly is not a true circle. I do not know what it is and I doubt if it could be analyzed. Mr. Cutshaw says: "The position taken by the slack side of a horizontal belt is not a segment of a circle but approaches a catenary."

It is a true catenary when the belt is at rest; when a belt is in motion, I know that the curve often changes to a position as indicated in Fig. 4. Just what that curve is I believe nobody knows; possibly it is indeterminate.

Several years ago, I developed a formula for the best belt velocity as follows: $V = 5.27 \sqrt{S}$ where V is the velocity of belt in feet per second; and S, the strength of belt in pounds per square inch.

This formula clearly shows that a strong belt has a considerable advantage over a comparatively weak belt and it is due largely to centrifugal tension.

W. F. SCHAPHORST.

Size of Boiler Steam Nozzle

WHAT IS the formula used for determining the correct size of steam nozzle for a boiler of given rating?

A. E. Q.

A. The steam nozzle on a boiler is designed to pass, at a given velocity, the maximum amount of steam that the boiler will be called upon to deliver. Usually this velocity is figured at an arbitrary maximum of about 8000 ft. per min., depending, of course, on the service that is to be rendered. Assume, for instance, that we have a 500-hp. boiler that is to be operated at a maximum rating of 200 per cent, or 1000 hp. If feed water and steam pressure conditions are such that the factor of evaporation is unity, i.e., that the boiler evaporates 34.5 lb. of water per hp. hr., the total evaporation will be $34.5 \times 1000 = 34{,}500$ lb. per hr. At an assumed pressure of 150 lb per sq. in., the specific volume of the steam is 2.753, so that the volume handled will be $34{,}500 \times 2.753 = 95{,}000$ cu. ft. per hr. or 1580 cu. ft. per min. For a velocity of 8000 ft. per min., then, the area would be $1580 \div 8000 = 0.197$ sq. ft., or 28.5 sq. in. D^2 is then equal to $28.5 \div 0.7854 = 36.2$ and $D = \sqrt{36.2} =$ approx. 6 in.

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CONTENTS

Making Steam for a Large State Institution. Illustrated..1085
Notes on Wind Motors. By Robert Grimshaw.....1089
Brickwork. By Zuce Kogan. Illustrated.....1090
Gas to Be Used for Industrial and Domestic Heating in Denver.....1093
Formation of Slag on Boiler Tubes. By Henry H. Bates. Illustrated.....1094
Operating Conditions Maintained at Dalmarnock Station. By C. H. S. Tupholme. Illustrated.....1099
Why a Diesel Engine Fails to Fire. By M. S. Howard...1103
Electric Motor Drive in the Rubber Industry. By Gordon Fox. Illustrated.....1105
A New Type of Water Flow Indicator for Transformers. By A. M. Rossman. Illustrated.....1108
Getting Next to an Absorption System. By John H. Ryan. Illustrated.....1109
Accident Prevention in Public Utilities.....1112
Saving Losses by Paying Men. By John U. Morris.....1114
Making Turbines Noiseless. By H. H. Lupinski, Illustrated.....1115
The Man Who Couldn't Come Back. By Robert Hamilton.....1116
Letters Direct from the Plant. Illustrated.....1118
Repairs to Loose Piston on a 2500-Hp. Engine. By Charles N. Shaw.....1122
Leveling with a Hose Full of Water. By W. F. Schaphorst.....1123
Installed Capacity and Output in 1922.....1123
Questions and Answers. Illustrated.....1124
Editorial. Slag on Boiler Tubes. Does your Plant have Character? If I were a Watch Engineer.....1126
Motor Operated Mechanism for Closing Oil Circuit Breakers. Illustrated.....1128
When Air Hose Is Disconnected, Coupling Also Acts as Valve. Illustrated.....1128
Swing Gate Valve Can Be Easily Reground. Illustrated..1129
Hoppes Co. Adds Vertical Feed Water Heater to Its Line. Illustrated.....1129
Portable Hoist Is Motor Driven. Illustrated.....1129
Standard Evaporator. Illustrated.....1129
Annual Meeting of the A. S. M. E., Dec. 4-7.....1132
Metropolitan Section of A. S. M. E. Announces Winter Program.....1132
A. I. E. E. Holds Four General Meetings in 1923.....1132
Annual Meeting of the American Society of Refrigerating Engineers.....1132
William Blake Wood.....1133
Health Hazards in Industry. By Helena V. Williams....1133
Coal Commission to Investigate All Facts Relating to the Industry.....1133
Power Exposition Will Demonstrate Plant Equipment....1134
Niagara Falls Project Making Good Progress.....1134
Don Pedro Dam Now 82 Per Cent Completed.....1135
Extension of Government Plant Under Way.....1135
Georgia Company Increases Capacity of Substation.....1135
Business Activity Maintained During September.....1135
News Notes.....1136
Books and Catalogs.....1138

Slag on Boiler Tubes

Recent years have witnessed great changes in the design of power plant equipment, particularly as regards size. Boilers and turbo-generators are being operated today with capacities which 15 or 20 yr. ago were entirely undreamed of, and we are using furnaces under the boilers in which there is ample room to park a couple of automobiles without crowding. This tendency towards the development of increasingly larger sized units is due to two main factors—first, the inherent higher economy of large units, and, second, their reduced size per unit of power generated. Considered from these points of view, the use of large sized units has many advantages.

Development in this direction, however, is not without its disadvantages. Certain troubles or operating difficulties, for instance, which in small sized units are of no great consequence are so magnified in the case of large size units as to become serious problems.

The formation of slag and scale upon the external surfaces of boiler tubes may be cited as one of the problems the seriousness of which has been augmented with the development of large capacity boilers. Scale and slag on boiler tubes has always been a source of trouble in boiler operation, but with small units its formation is not particularly rapid, and it is easily removed by periodic cleaning. To this end there have been developed a number of devices for mechanically removing the slag deposits.

While these devices are effective, the removal of slag after its accumulation is not the most satisfactory method of combating this trouble. Particularly where large boilers are operated at high ratings, the slag forms so rapidly that the time required for shutdown for its removal represents a considerable monetary loss. The solution of the problem obviously is not one of slag removal, but rather one of slag prevention.

Now, in order to prevent the accumulation of slag on boiler tubes, one of the first steps to be taken is to determine what causes the formation of slag. Knowing the causes, we shall be able to devise means for its prevention.

The determination of the exact means by which slag is deposited and the chemical reactions involved is no simple task, and while a number of theories had been advanced, until the present time no real attempts were made to investigate the matter.

Just recently, however, a series of experiments were conducted by the Westinghouse Co., assisted by the Bureau of Mines, for the purpose of investigating the problem, and while much still remains to be done, the results of the experiments have enabled us to make certain deductions. Although a chemical problem, the investigation seems to indicate that a fruitful field for the development of means for slag prevention is in furnace and boiler design. At the present time other experiments are being conducted along lines of preventing slag formation.

An account of this investigation, together with conclusions arrived at, is published in the current issue in an article by Harry H. Bates. This article should be of interest to all interested in boilers or furnaces either from the standpoint of design or operation.

While there is still need for further development of apparatus for mechanically removing soot and slag from

boiler tubes, these experiments are steps in the right direction and it is to be hoped that they may lead to the development of methods for preventing slag on the external surfaces of tubes as effective as those now employed for the prevention of scale on the interior surfaces of the tubes.

Does Your Plant Have Character?

In going through the boiler plant at the River Rouge power house of the Ford Motor Co., the visitor is usually amazed at the cleanliness which is everywhere apparent. It is possible to climb over the entire setting without soiling the clothes or the hands as much as would be the case on an ordinary street car ride. That this cleanliness was an expected feature of the operation is shown by the fact that there is no partition between the boiler room and the turbine room.

Powdered coal, gas and oil are used for firing under these boilers and while good operating conditions may be an aid to cleanliness, it is evident that the plant does not just keep itself clean. There is back of this condition an underlying motive which may be found in the spirit of the organization.

It is a fairly safe criterion in engineering work to assume that the job that looks good is more apt to be correct mechanically than an installation which is sloppy in its make-up. The same thing holds for operation; the clean plant is usually more efficient and safer than the dirty one.

In either case, pride has been stimulated and when pride is aroused, whether in workmanship or in operation, the results are usually better all around.

Some day when you step into your plant, just look at it from the unprejudiced viewpoint of a visitor. Does it strike you that the most is being made of the opportunities? Does your plant have character? If it does, the fact will probably show up in the way it is maintained.

If I Were a Watch Engineer

Having arrived at the position of engineer, one to whom the operation of the machinery in the engine room is entrusted, I would know that I no longer was a beginner in the power plant field. By this time I should certainly know the smell of hot oil, be acclimated to the temperature and atmosphere of the engine and boiler rooms, accustomed to the sound of properly operating machinery and thus able to recognize unusual sounds. My training must have given me confidence in my ability not only to start and stop the machinery, but to make the necessary delicate adjustments of engine valves, valve gears and governors, bearings, pressure regulating valves, thermostatic control equipment and a hundred and one other mechanical devices that go to make up the modern power plant.

Each machine or device in the plant has a duty to perform and I must have been familiar with those functions, else I would not have been given the position of engineer. Many repairs will be turned over to me, so I must have acquired considerable skill in the handling of machinist's tools and methods. So, all things considered, I would be far from a novice if I were a watch engineer.

No matter how much I may know about the machinery in the plant or what my skill may be in handling it, my success will be limited by the mental attitude I have towards my work, the relative importance in which I place each of my various duties and my work as a whole to other positions about the plant, the interest I take in doing my work, the confidence with which I undertake various tasks, my attitude towards other members of the force, my ability to comprehend new equipment and ideas, my initiative in handling difficult situations, and many other qualifications that are the direct results of correct thinking and right living.

So, if I were a shift engineer I would first of all make sure that my technical knowledge was more than adequate to take charge of the operation of the entire plant, then I would make a very careful study of myself to see that I personally was not standing in the way of my own progress. I would analyze every personal motive back of my actions, back of my conversations, back of my recreation activities, back of my home life.

My next step forward will be to a position as chief engineer or assistant chief. It is a big step, like changeing from a trade to a profession, from work that is principally routine to that which presents a continuous succession of new problems involving machinery, methods, applied sciences, finances and men. I must prepare myself for this step, and the greatest problem in this preparation is the molding of my own character and personality into that which is not desirable for this higher position. To this end I would form intimate acquaintanceship with leading engineers in the community and endeavor to determine what characteristics they possessed which made them successful, then make my own motives and ideals conform with the highest that I could discover.

All this, you will say, is theory, and I agree, but if I were an engineer I would know that back of all practical success are laws which govern the outcome of every process, so if I wish a certain outcome I must apply the correct laws whether they be physical, chemical or psychological. If I were a watch engineer I would search for these laws with all diligence.

Power Plant Slogans

Keep and Analyze Operating Records in Every Power Plant.

Develop Water Power Sites.

Promote Health and Safety in Power Plants.

Handle Coal and Ashes Mechanically.

Employ Engineers for Engineering Work.

AT A RECENT meeting of the executive board of the Federated American Engineering Societies a resolution was passed authorizing the president to appoint a committee of engineers to make a thorough study of the Muscle Shoals project from an engineering standpoint, placing the facts in a clear and comprehensive manner before the public. The work of raising the necessary funds has already been started and organizations which have studied this project have offered to place their data and statistical information in the hands of the committee.

Motor Operated Mechanism for Closing Oil Circuit Breakers

THE GENERAL ELECTRIC Company has recently perfected a motor driven centrifugal mechanism for closing oil circuit breakers. Although it was primarily designed for application in connection with the remote control of circuit breakers on alternating current lines up to and including 800 amp. at 15,000-v., it has also been found adaptable to use on the automatic reclosing equipments recently developed by the company. It can be used on direct current circuits by substituting a direct current motor. The

NEW MOTOR DRIVEN, CENTRIFUGAL MECHANISM FOR CLOSING CIRCUIT BREAKERS (COVER REMOVED)

mechanism, which is motor-driven, makes use of centrifugal force in a manner similar to that of a governor on a steam engine.

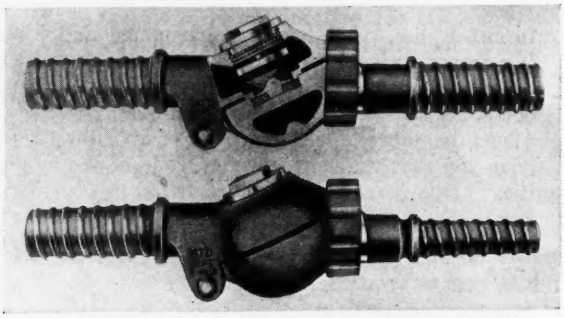
The operation is as follows: The motor, when its circuit has been closed by a control relay, rapidly rotates a pair of weights, the centrifugal force of which closes the breaker through a mechanism. When the control relay is actuated, by push button, or other circuit closing device, it closes the motor circuit, and holds it closed until the breaker closes, even if the actuating device is opened. When the breaker is closed, the closing current is broken by an auxiliary switch mounted on the breaker mechanism. A feature of the device is that no separate source of direct current is necessary for its operation. The motor is 220-v. single phase, is equipped with self-lubricating bearings, and draws about 15 amp. starting current.

The device is provided with trip coils which are separate from the closing mechanism and the breaker trips free of the closing mechanism. Four coils are provided any or all of which may be either shunt trip coils or secondary current transformer coils. Tripping from the control switch is accomplished through one of these shunt trip coils.

The main features of this mechanism are the simplicity of its construction, no gears, clutches or springs being used; the positive operation is obtained by the rapidly increasing centrifugal force as the weights swing outward, insuring the completion of the stroke of the breaker, the absence of shocks or jars, since the mechanism automatically adjusts itself to the load; the silence of operation, and small space occupied.

When Air Hose Is Disconnected Coupling Also Acts as Valve

FOR SHORTENING or lengthening air hose lines or removing air tools, a coupling has been developed which also acts as an automatic check valve. As a result, it is possible to dispense with the valve at the pipe line if desired; or if such a valve is retained, it is possible to remove a tool or change the hose length without shutting off the pressure on the line. In making a connection, kinking of the hose is eliminated as



AIR CONNECTION IS MADE BY CLAMPING TWO HALVES TOGETHER WHICH ALSO OPENS CHECK VALVE

the two halves of the coupling are simply clamped together, no turning movement being necessary.

From the accompanying illustration, it will be noted that the half containing the automatic check valve is machined and so constructed that the pressure of the air in the line comes on top of a brass stem with a renewable leather disc valve facing. This leather disc may be replaced without the use of any special tools. The valve stem is centered by a reamed hole in the valve cap. Two projections with a cross bar extend beyond the face of the valve seat, their purpose being to protect the seat when the valve half is dragged along the floor at the end of a hose.

The hose shank half has two small projections beyond the valve face. These push the valve open when the connection is being made, admitting the pressure to that section of the line. This part is recessed to receive a gasket which is permanently cemented in place. An eccentric clamping ring locks the two halves together.

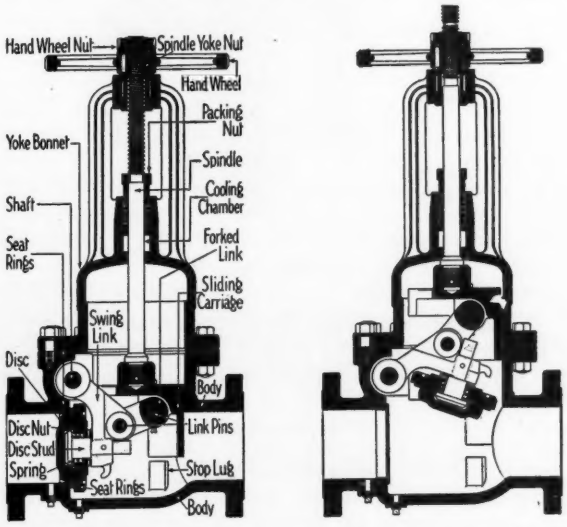
This coupling is being manufactured by the Robinson Machine Co., of Muskegon, Mich.

Swing Gate Valve Can Be Easily Reground

EASE OF access for regrinding the valve seat is one of the features of a swing gate valve which has been developed by Schutte & Koerting Co., of Philadelphia.

As shown in the illustration, the valve seat is at right angles to the horizontal axis of the body. Closing is effected by the disc which is rigidly connected to a swing link suspended on a shaft. Attached to the swing link is a threaded disc stud which is secured to the valve disc by means of a disc nut. The purpose of the spring shown, is to prevent vibration of the disc and at the same time to give a slight flexibility of operation.

Opening and closing the valve are accomplished by means of a sliding carriage that moves at right angles to the horizontal axis of the body. This carriage is rigidly



REGRINDING SWING GATE VALVE SHOWING THE DISK IN CLOSED AND OPEN POSITIONS

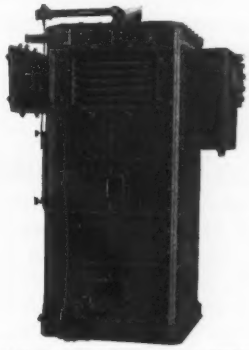
attached to the vertical rising spindle and can be made to move up and down by turning the hand wheel.

In order to grind in the valve seat, the bolts fastening the bonnet to the housing are first removed. Then the pin connecting the forked link and swing link is removed and all the internal parts are taken out with the exception of the swing link and valve disc. The grinding operation is performed by rotating the valve disc, back and forth, by means of a wrench which is provided for the purpose.

Hoppes Co. Adds Vertical Feed Water Heater to Its Line

BECAUSE of the demand for a vertical type feed water heater, the Hoppes Manufacturing Co., Springfield, Ohio, has added such a heater to the line of horizontal heaters which it has been building for a number of years. In general, the features of the new type are the same as those used in the horizontal line.

Pans or trays are used and are so designed that the water follows the under side in a thin film which is in direct contact with the steam. As the steam also comes in contact with the top surface, the effective heating surface is practically doubled. Oil catchers of the induction chamber type are provided, which are also equipped with a trap for the oil drip and overflow. Regulation

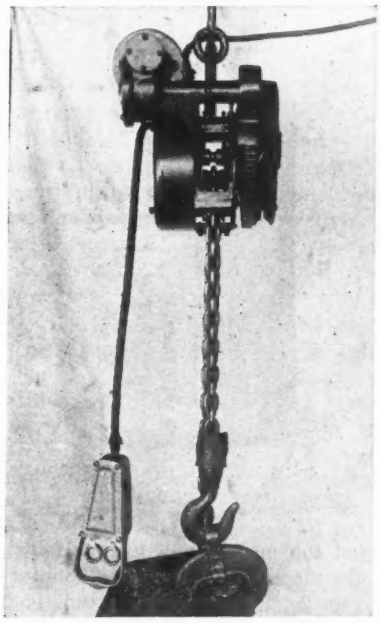


THIN FILM OF WATER FOLLOWS THE UNDER-SIDE OF PANS IN DIRECT CONTACT WITH THE STEAM

is obtained with a valve of the balanced double seat type and the float used is drained to atmosphere. The heater doors are packed with asbestos rope, in a groove, which makes a joint that does not require frequent renewals.

Portable Hoist Is Motor Driven

A RECENT development in the line of material handling devices is a portable chain hoist which has been electrified by the application of a specially designed heavy duty motor. While this outfit is regularly furnished as a complete hoist, the motor unit can be applied to chain hoists already in service.



SELF CONTAINED MOTOR UNIT CAN BE APPLIED TO STANDARD CHAIN HOISTS ALREADY IN SERVICE

In mounting the motor, a malleable iron bracket is used which houses the motor, friction clutch and re-

duction gearing. The clutch protects the hoist from damage due to over-running and also protects the motor from severe overloads. As will be noted from the illustration the control is taken care of by a self contained pendant controller which may be operated by the fingers of one hand. The armature shaft and worm are carried in heavy duty ball bearings with liberal provision made for lubrication.

These hoists are being built by the Motorbloc Corporation, of Philadelphia.

Standard Evaporator

WATER sufficiently pure to give the best results as boiler feed is seldom found in a natural supply. By some means it must be purified so as to remove the corrosive and scale forming impurities, and evaporation, or distillation is a method coming into favor, especially for plants where boilers must be forced to the limit, where it is essential that heating surfaces be kept always clean.

One form of apparatus for this purpose, made by the Standard Water Systems Co. of Hampton, N. J., is illustrated herewith. It has a vertical round shell, with large vapor space to insure free disengagement of vapor and prevent priming, dished heads, and a door curved to the same radius as the shell and held in place by shed bolts and with double countersunk spring washers under the nuts so that "breathing" or loosening at the gasket joint is prevented.

Heating coils for the steam are carried by the door, and removed with it for inspection and cleaning. These are of copper tubing, specially rolled with round section at the top and crescent section in the lower part, as shown in Fig. 2, to give more uniform steam velocity as part of the steam is condensed. The coils

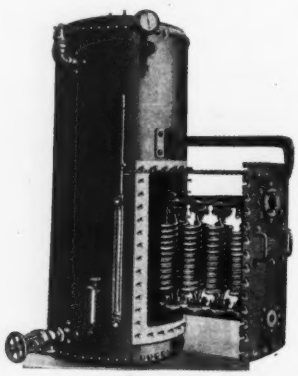


FIG. 1. STANDARD MULTICOIL EVAPORATOR WITH HEATING UNIT WITHDRAWN

are connected top and bottom to manifolds which are bolted to the door, the details of connections being shown in Fig. 2. The end of the coil is flared, and drawn against the tapered end of the manifold ripple by a bronze ferrule having raised points to give a secure hold on the tube ends. The ferrule is drawn into place by a yoke and two stud bolts.

Connections to the shell are provided near the bottom for feed water inlet and for blow off, and in the top head for vapor outlet; also for gage glass fittings, pressure gage and safety valve as shown in Fig. 1.

The heating unit, attached to the door is removable, and is carried on a sliding hanger attached to the top of the door. In the door is an inspection opening, covered by a screwed cap, large enough to allow the coils to be sprayed with cold water to crack off any scale that may become attached to them.

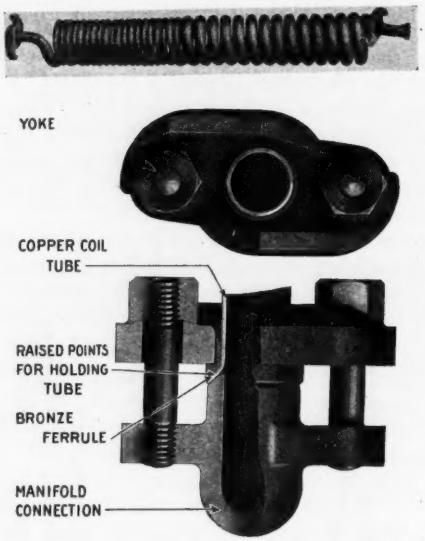


FIG. 2. HEATING COIL AND DETAIL OF MANIFOLD CONNECTION

These evaporators run from 22 in. diameter by 6 ft. 9 in. high with capacity of 10 T. of vapor in 24 hr., up to 78 in. diameter by 9 ft. high and with capacity of 80 T. in 24 hr.

Some Gasoline Engine Figures

IT HAS BEEN estimated that there will be 13,500,000 gasoline engines in use in 1923. Figuring an average of 420 gal. of fuel a year for each, the petroleum industry will have to provide 5,670,000,000 gal. of gasoline during the twelve months. At the present rate of one barrel of gasoline to 4 bbl. of crude, this would require a crude oil production of 540,000,000 bbl.

THE AMERICAN COMMERCIAL ATTACHE at Santiago, Chile, advises the Department of Commerce that although that office receives catalogs from American manufacturers in each mail, it is not collecting them with sufficient rapidity to meet the requests for information which are steadily being received. There is an especially active demand for catalogs of machinery of all kinds, not because of any particular prosperity among Chilean manufacturers, but for the reason that the representation for specialized American machinery is rather lacking in Chile except in certain lines where the makers are represented by their own salesmen or by an unusually alert agency. Many orders for machinery have been placed in Europe simply because of a lack of knowledge of the American product or in default of accessible American catalogs and price lists.

NOTICE that two-thirds of "Promotion" consists of "Motion."—Forbes Magazine.

Operating Problems Discussed by N. A. P. R. E. at St. Louis

DIRECT brine sprays for cooling room systems, high speed compression, the refrigerating engineer's relation to the business organization, and economies of absorption machines were subjects which evoked the most discussion at the 13th annual convention of the National Association of Practical Refrigerating Engineers, held at St. Louis, from Nov. 1 to 4.

R. H. Tait, consulting engineer of St. Louis, in his paper on "New Refrigeration Appliances, Apparatus and Processes," showed that the present trend of development is toward the use of direct brine sprays for reducing the air temperatures used in cooling rooms of the packing industry. The uniflow engine, oil engine, compound compressors, water treatment, dehydrated air for low pressure agitation, and automatic regulating equipment were other features of modern practice which were mentioned.

Brine Spray Shows Good Results

It was brought out by Mr. Carlson, of the Minneapalis plant of Armour & Co., that this organization has had successful experience with brine sprays for cooling. Some 10,000 spray nozzles are in use and the sprays are nine decks high. It is possible to pull the cooling room temperature down from 36 or 37 deg. F. to 28 or 29 deg. F. in 24 hr., which means that the beef is ready for cutting in about half the time formerly required when cooling coils were used. On account of the higher degree of air saturation, shrinkage of beef has been reduced which, on a basis of selling, price amounted to 24c a head. The cost of refrigeration is 11c per head.

The brine is leached in sponge tanks in order to clean it and reduce clogging of spray nozzles. A brine of 60 Baumé is used. It is necessary to add 40 T. of salt each month, for make-up purposes.

High speed compressors conserve floor space, can be electrified at less expense by direct connection and are now as reliably built as slow speed compressors of the old type, according to A. J. Hecker, of the St. Louis Refrigerating & Cold Storage Co., in his paper on "High Speed Ammonia Compressors." Such compressors were considered as those running from 100 to 250 r.p.m.

Mr. Sloan of the Triumph Ice Machine Co., however, differed slightly, stating that two years ago their organization had sold 90 per cent high speed compressors while at present the tendency was toward medium speed machines of about 100 r.p.m. This was due, he asserted, to the fact that the motor manufacturers had come out with slower speed motors for such work. From a standpoint of the horsepower per ton of refrigeration not much is to be gained by the higher speed, he said.

In a further consideration of high speed compression, J. H. H. Voss, consulting engineer of New York, presented a paper on "Ammonia Compressor Valves." He showed that valves of the poppet type were not as reliable as those of the plate type for high speed work. A valve, he said, should have large passage areas both for suction and discharge, should have quick opening and closing movement, the joint should be tight between the valve and the seat and they should be constructed from a safety standpoint. He cited several cases where the breaking of spindles in the poppet valves had caused the wrecking of compressors because of the parts being blown into the cylinder.

If the refrigerating engineer took a more active interest in the business end of his organization and considered all improvements from such an economic standpoint the results would be better for the profession, stated Victor J. Azbe, consulting engineer of St. Louis, in his paper on "Economics of Refrigerating Plants." He went on to say that frequently engineers overlook the items of depreciation, insurance, taxes, increased overhead and profit on the investment, in making recommendations for changes in or additions of equipment. As a result their recommendations are sometimes looked on with suspicion. Furthermore, stated Mr. Azbe, unless all equipment in the plant is operating at its maximum efficiency, engineers should seek to improve what they have without going ahead on something new.

Fair Average Operating Conditions

In the discussion of this paper the question arose as to what constituted fair economic operating conditions. It was mentioned that in a distilled water plant from 4 to 8 T. of ice should be made for every ton of coal used, in a steam driven plant from 7 to 16 T. of ice for each ton of coal and in a plant using central station power 15 to 28 T. of ice for every ton of coal.

In kilowatt hours it was brought out that 48.5 kw.-hr. per ton of ice, including power for auxiliaries, is a fair average figure. In an oil engine plant, with electric driven auxiliaries, 5 gal. of oil per ton of ice is considered good operating. With 18 deg. Baumé oil at 5c to 6c a gallon this figures a power cost of 25c to 30c for each ton of ice made.

Absorption machines came in for considerable attention as there were two papers on this general subject. "Principles and Practical Operation of the Absorption Refrigerating Machine" was the paper presented by Heywood Cochran of the Carbondale Machine Co. and "Economy and Efficiency of the Absorption System for Production of Low Temperatures" was the one given by G. A. Pardee of Henry Vogt Machine Co.

In the discussion which followed the papers Mr. Cochran made the statement that the absorption machine was far from dead, as his organization had sold more of the machines during the past season than ever before. It was pointed out by Mr. Pardee that the absorption system has a definite place in the industry. For instance, if exhaust steam is available for the absorption system will furnish refrigeration at a cost far below any other system. If a compression system is to be enlarged it is often possible to install an absorption system in conjunction with it and the waste steam from the compression system can be used.

The 13th convention was in every way a successful affair. Some 450 engineers were in attendance and a keen interest was manifested in the discussion. Nearly 50 manufacturers of refrigerating equipment and accessories exhibited their apparatus.

Officers elected for the next year are: H. T. Wyte, chief engineer, Pacific Fruit Express, San Francisco, president; E. J. McCormick, supervising engineer, Greater New York Ice Co., Brooklyn, vice-president W. F. Davis, chief engineer, Lily Ice Cream Co., Memphis, vice-president; C. W. Chapman, chief engineer, Detroit Refrigerating Co., treasurer; Erle Ormsby, general manager, Merchants Ice & Coal Co., St. Louis, chairman of board of directors; E. H. Fox, Chicago, secretary. Memphis, Tenn., was chosen as the next convention city.

Annual Meeting of the A. S. M. E. Dec. 4-7

COOPERATION WITH other organizations will distinguish the Forty-third Annual Meeting of the American Society of Mechanical Engineers at the Engineering Societies' Building in New York City from Dec. 4 to 7, 1922. Joint sessions have been arranged with the American Economic Association, the American Society of Refrigerating Engineers, the American Society of Safety Engineers, and the Stoker Manufacturers' Association. There will also be a strong bond with the National Exposition of Power and Mechanical Engineering which will begin at the Grand Central Palace on the last day of the meeting. With these features in prospect, an unusually large gathering of engineers from all sections of the country is expected.

The joint session with the American Economic Association on the evening of Dec. 6 will be one of the outstanding events of the meeting. Addresses by Dr. W. C. Mitchell of the National Bureau of Economic Research, who will speak on Making Money and Making Goods, and by E. M. Herr of the Westinghouse Electric and Manufacturing Co., who will have as his subject The Human Problem in Industry, will be followed by discussion led by Prof. H. R. Seager of Columbia University, President of the American Economic Association; Dean Dexter S. Kimball, President of the American Society of Mechanical Engineers; and H. F. Loree, President of the Delaware and Hudson Railroad Company.

As usual, the technical sessions will bring out papers dealing with a wide variety of subjects. Among the most valuable of these from the standpoint of the power plant man will doubtless be a series dealing with stoker history and the characteristics of the principal types of stoker, which will be presented at a symposium on this subject which is to be held jointly with the Stoker Manufacturers' Association. The paper on Commercial Economy of High Pressure and High Superheats in the Central Station, to be presented by G. A. Orrok at another session, should also be productive of valuable results.

Public hearings on the revision of the Boiler Code of the society, which has formed the basis for laws in eighteen states, will be held on the first day of the meeting according to the tentative program. There will also be public hearings on Power Test Codes covering feed water heaters and reciprocating displacement pumps.

A tentative list of the sessions and social events to be held each day of the meeting follows:

Monday morning: Local Sections Conference, Public Hearing on Boiler Code. Afternoon: Joint Session with American Society of Refrigerating Engineers, Public Hearing on Boiler Code. Evening: Presidential Address and Reception.

Tuesday morning: Management Session, Materials Handling Session, Machine Shop Session, Public Hearing on Power Test Codes. Afternoon: Session on Training for the Industries, Steam Tables Session, Research Session, Session of Miscellaneous Technical papers. Evening: Informal Dinner and Smoker.

Wednesday morning: Fuels Session, Railroad Session, Session of Miscellaneous Technical Papers. Afternoon: Business Session, Ladies' Tea. Evening: Joint Session with American Economic Association.

Thursday morning: Power Session, Standardization Session, Joint Session with American Society of Safety Engineers. Afternoon: Power Show opens 1:00 p. m. Aeronautic Session, Ordnance Session, Forest Products Session. Evening: Dinner dance.

Excursions to points of engineering interest about New York will be arranged.

Metropolitan Section of A. S. M. E. Announces Winter Program

THE METROPOLITAN SECTION of the American Society of Mechanical Engineers has announced a tentative calendar for the season of 1922-1923 which bids fair to equal in interest the very successful program of last year. Besides joint meetings with the A. S. C. E., A. I. M. E., and A. I. E. E. on December 13 and March 21, with subjects to be announced, and the annual meeting of the society on December 4—8, the following events are in prospect:

October 31—Industrial Heating Operations, Newark, N. J.

November 14—Marine Boilers, New York City.

November 28—Textile Meeting, Paterson, N. J.

January 10—Economics of Cold Storage, New York City.

January 23—Heat Resisting Alloys, Newark, N. J.

February 13—Coal Handling for Power Stations, New York City.

February 27—Problem of Power Station Make-Up Water, Brooklyn, N. Y.

March 13—Railroad Meeting, New York City.

March 27—Spring Get-Together, New York City.

April 10—Ordnance Meeting, New York City.

May 8—Management Meeting, New York City.

A. I. E. E. Holds Four General Meetings in 1923

AS ANNOUNCED about a year ago, the Board of Directors of the American Institute of Electrical Engineers adopted the policy of holding four general meetings of the Institute each year, all other meetings to be under the auspices of the various sections.

In accordance with this policy, there have been four general meetings of the Institute held during the year 1922; and the following four general meetings have been scheduled for the year 1923: Midwinter Convention, New York, February 14-16; Spring Convention, Pittsburgh, in April; Annual Convention, Swampscott, Mass., June 25-29; Pacific Coast Convention, San Francisco, in September.

The Meetings and Papers Committee is already active in preparing technical programs for the meetings and it is expected that the preliminary program for the Midwinter Convention will be announced at an early date.

Annual Meeting of the American Society of Refrigerating Engineers

THE AMERICAN Society of Refrigerating Engineers will hold its annual meeting at the Hotel Astor, New York City, on Dec. 4—6, 1922. The meeting will open with a business session on the morning of Dec. 4. This will be followed in the afternoon by a joint meeting

with the A. S. M. E., at which the following papers will be presented: Design of Cooling Towers, by Prof. Clark S. Robinson, of Cambridge, Mass; Economic Thickness of Insulation in the Refrigerating Field, by P. Nicholls of Pittsburgh, Pa. In the evening, Dr. E. F. Mueller, of the Bureau of Standards, will present a paper on the Properties of Ammonia.

The programs of the professional sessions of Dec. 5 and 6 have not yet been definitely fixed. The president of the Society, Harry Sloan of Milwaukee, Wis., will preside at these sessions.

On the evening of Dec. 5, the society will hold its Annual Dinner at the Hotel Astor.

William Blake Wood

MR. WOOD, a leader in the industrial life of Hudson, N. Y., and President and General Manager of the Gifford-Wood Co., passed away at the Albany City Hospital on Oct. 28th. He had been ill for some time with a disease which baffled the best medical science of the country.

Mr. Wood was born at Arlington, Mass., July 15, 1869, and was educated in the public schools of that town and in the Cotting High School. Later he attended the Mass. Inst. of Technology, and on leaving went with the firm of William T. Wood & Co. in the manufacture of ice tools.

In 1896, he became a partner in the firm which, in 1905, united with Gifford Brothers under the name of the Gifford-Wood Co., with plants in Arlington and Hudson. In 1911 it was found necessary to enlarge the facilities, and the Arlington plant was moved to Hudson, N. Y., a new plant being erected.

At the time of the consolidation, Mr. Wood was made General Superintendent, and later he became Secretary, Treasurer, Vice-President and finally President and General Manager.

Mr. Wood was a prominent member of the commercial, social and religious organizations of his city, and was dearly beloved by all who knew him. His untimely death will be felt as a distinct loss to the community as well as to his friends and associates.

Health Hazards in Industry

By Helena V. Williams.

IT HAS long been recognized that each industrial occupation has certain hazards, but the worker himself has not yet become sufficiently impressed that he should guard against diseases and give thought as to whether the conditions surrounding his employment may affect his health.

Tuberculosis, that insidious enemy of the wage earner, is said to be primarily a disease of producers, for the reason that one-fourth of all persons who die between the ages of 15 and 45, are its victims. Out of the million cases of active tuberculosis in this country, fully 60 per cent are at the age period when they are engaged in gainful occupations.

In these days of efficient and comfortable safety devices, it is quite possible for the worker to protect himself adequately against dust and its insidious effects. Dark, poorly ventilated factories and workshops into which little or no sunshine penetrates, or where windows are always tightly shut, impair the workingman's health and render him an easy prey to disease.

All too often the working man, rather than his occupation, is to blame. His working conditions, surroundings and hours of work may be ideal; but if at the end of the day he wastes his energy by remaining late hours in the pool room or some other place of amusement, he undoes what his employer may have tried to accomplish for him. Not that recreation is not desirable and even necessary, but moderation should be the watchword here as in all other things.

Nourishing food and healthful exercise are essentials to one's physical well-being. The food may be of the simplest, but it should be provided in sufficient quantities and be of the right sort. Meat, all the green vegetables, cereals, and the starchy foods, such as potatoes, macaroni and rice are good; but sweets, pickles and pastries are best left off the regular diet.

Finally, a periodic physical examination is the best way to assure oneself that there is really nothing the matter. It is difficult, of course, to persuade oneself to pay a doctor for an examination when one is feeling well; but it is a practice worth cultivating in the long run. The money that is saved in pain, doctor's bills and mostly in wages by treating early symptoms is many times greater than the cost of prevention.

In order to increase the education of the working man and his family in the cause, prevention and control of tuberculosis, tuberculosis associations throughout the country are supplying public health nurses, children's camps, nutrition classes, clinics, etc. These are supported by the funds raised in the annual sale of Christmas seals. Everyone is given a chance at this time to co-operate in this movement which aims to teach. The sale of seals will be conducted throughout the country in December.

Coal Commission to Investigate All Facts Relating to the Industry

AT SEVERAL conferences held by the recently appointed fact-finding commission and delegations representing the mine workers, bituminous and anthracite operators, the points to be taken up in accordance with the Act of Congress, were presented. It is the intention of the commission to study the following points in relation to the industry: Ownership and titles of the mines, prices of coal, the organization and persons connected with the coal industry, cost of production, profits realized by operators or owners during the last ten years, profits of other persons or corporations having to do with production, distribution, or sale of coal; labor costs, wages paid, wage contracts, irregular production, waste of coal, suggestions as to the remedy for waste, the conditions generally under which coal is produced, and distribution.

Detailed study will also be made along these lines: The causes which induce strikes, thereby depriving interstate carriers of their fuel supply and otherwise interrupting the flow of interstate commerce. Standardizing the mines upon the basis of their economic productive capacity and regarding the closing down of mines which fall below the standard. Ascertaining and standardizing the cost of living for mine workers and the living conditions which must be supplied or afforded in order to surround the workmen with reasonable comforts and

standardizing also as far as practicable the amount of work a man shall perform for a reasonable wage, recognizing the value and effect of such surroundings in respect of their efficiency. Standardizing a basis of arriving at the overhead cost of producing and distributing the coal, including delivery at the door of the consumer, recognizing in this compilation that the standardized cost of living to the miners should be the first and irreducible item of expense.

The operators and workers have expressed their willingness to assist the commission in securing this information which is to be used by the government in working out some method to stabilize conditions in the industry. In this connection, the operators have been asked to express their opinion as to what specific data should be secured under each of the topics enumerated in the law, how the data can best be secured, and what additional topics should be covered.

Power Exposition Will Demonstrate Plant Equipment

At the Grand Central Palace, N. Y., Dec. 7 to 13, the National Exposition of Power and Mechanical Engineering will show on a large scale mechanical and power plant apparatus so that the present state of development will be apparent to the highly trained technical man and to the layman.

Realizing thoroughly the need for greater public information and understanding of the engineering problems of the day, the Advisory Committee has set aside a large centrally-located space at the Exposition, where will be shown models of the various devices that enter into the process of taking coal from the mine, handling it at the power plant, turning it into steam, using the steam to generate electric power and sending the current out through wires to the consumer.

As an excellent example of the manner of preparing anthracite coal for market, the model of the famous Loree breaker of the Hudson Coal Co. will be exhibited. This model is a replica of the largest breaker in the world, which was erected and put in operation in 130 days and in 1921 handled 591,000,000 T. of coal. The model will show the breaker in operation, crushing the large lumps of coal, sizing it through screens and passing the sized coal through jigs which separate the refuse material.

Development of the power station itself will be illustrated by a series of models of the important central stations in New York City The original station erected by Thomas Edison in Pearl Street will appear beside the more modern Waterside Stations and the recent Hell Gate Station. This last station is reproduced to a scale of ¼ in. to the foot, showing the steam and electric apparatus in the plant and the various boiler room and turbine room auxiliaries as well as the elaborate machinery for handling the enormous tonnage of coal and ashes. A study of the many complicated devices in this well-designed plant will emphasize the great knowledge and skill required to provide electricity, now absolutely necessary, but which 40 yr. ago was little more than a laboratory phenomenon.

In addition to the public central stations mentioned above, it is planned to show a model of one of the well known large industrial power plants.

To enhance further the educational and informative value of the exposition, each of the exhibitors will demonstrate the fundamentals underlying the operation of his apparatus by simulating actual operating conditions as nearly as possible in the exhibits. If practical, apparatus will be shown in motion, otherwise complete diagrams will be displayed.

All members of engineering societies who have problems relating to power and mechanical engineering will be admitted on presentation of their membership cards. The societies who have been invited to the Exposition are: Stoker Manufacturers Assn.; American Institute of Electrical Engineers; American Economic Association; American Society Civil Engineers; American Institute of Mining and Metallurgical Engineers; Society of Industrial Engineers; Society of Welding Engineers; American Society Heating and Ventilating Engineers; National Electric Light Association; and Building Managers and Owners Association.

Realizing the great importance of the Exposition to the operating engineer, the National Association of Stationary Engineers is organizing to attend the Exposition in a group. The New York Building Superintendents Association will also attend in a body, as will the Technical Publicity Association and the Blue Room Engineering Society of New York.

The Committee which is guiding the Exposition consists of Irving E. Moultrop of the Edison Electric Illuminating Co. of Boston, Chairman; Dexter S. Kimball, President, A. S. M. E.; Alexander G. Christie, Chairman Power Division A. S. M. E.; Fred Felderman, National President N. A. S. E.; Milan R. Bump, Past-President N. E. L. A.; N. A. Carle, Vice-President Public Service Production Co. of New Jersey; E. B. Katte, Chief Engineer Electric Traction N. Y. C. R. R.; Fred R. Low, Editor McGraw-Hill Publishing Co.; David Moffat Myers, Consulting Engineer; Calvin W. Rice, Secretary A. S. M. E.; and the Managers, Charles F. Roth and Fred W. Payne, with offices in Grand Central Palace, New York.

Niagara Falls Project Making Good Progress

John L. Harper, vice-president and chief engineer of the Niagara Falls Power Co., recently announced that the mile-long power tunnel, 33 ft. in diameter, from the upper Niagara River at Port Day to the hydraulic basin near Main St.; the inlet and outlet basins, piers and gates; the three penstocks from the outlet basin down to the foot of the lower river embankment; the hydraulic power house, and the three 70,000 hp. generating units will all be completed next May and their operation then started. The development work was started two years ago.

"The power tunnel, which has been fully excavated except for a 25-ft. stone wall separating its upper heading from the Port Day intake basin, is being lined with 18 in. of concrete," Mr. Harper said. "It is now 60 per cent lined. The great concrete piers at the Port Day intake have been built but the gates have not yet been constructed. Two penstocks have been fully excavated and one is being lined with concrete. A third penstock is being excavated. The concrete bell mouths from the tunnel outlet basin into the mouths of two of the penstocks have been completed. In the powerhouse addition below the embankment one of the new generating units is

being set up now, with this work well along. The total cost of the entire new development works will be, as originally estimated, $11,000,000.

Mr. Harper and his staff of engineers are working out an engineering problem to determine whether it will be practicable to shut off the flow of water from the upper river into the Hydraulic Canal when the water is turned into the new tunnel next May, in order that the bed and sides of the big power canal may be cleared of large rocks, smoothed and repaired.

Don Pedro Dam Now 82 Per Cent Completed

THE CONCRETE dam that the Modesto and Turlock irrigation districts are building across the Tuolumne River in Stanislaus County, California, is now 82 per cent complete.

The turntable at the head of the steep incline on the line of the tramway being constructed to lower the power house machinery is completed, track is laid down the steepest part of the slope and trestle work to carry the track across the face of the dam is well started. The derrick to handle the balanced valves to control irrigation water is erected in position and assisting in placing the steel trashracks over the lower irrigation outlets.

Recent work brought the lowest section, that on the south side, up to elevation 1060, completing the structure, except for the diversion channel, to a height of about 165 ft. But few more days' work can be done with the chutes in their present position, and in anticipation of the next move the steel trestle is being extended over the top of the dam about 100 ft. farther toward the south side. The chutes will then be resuspended from the end of this section, 580 ft. from the south end of the dam.

Extension of Government Plant Under Way

ACTUAL CREATION of one of the biggest governmental power plants and heating units in the world is now in full swing at Washington. As related in these columns before, light, heat, power and hot water, as well as refrigeration for the Capitol, House and Senate Office buildings, will continue to be supplied by the Capitol plant; but in addition, the same service will be extended to government buildings near Union Station. These additions will care for the utility requirements of the Washington City Post Office, the Government Printing Office, the Botanic Gardens, and the Coast and Geodetic Survey buildings.

Excavation of the tunnels for conduits, and steam pipes is now under way from the Senate office building to the Post Office. Connections with the Botanic Gardens, which cover hundreds of acres, commenced about Nov. 1, the route being under the present D St. grade. A 5 by 7-ft. tunnel through the Post Office will link the Senate tunnel to the Government Printing Office. William T. Cush, the contractor, has assured Engineer Cook that the work will be finished within 6 mo. Installation of cables and lining of the tunnels, and placing of mains is to be done in 240 days. Space has been cleared for the two new boilers supplied from the Babcock & Wilcox works at Garfield Pk. This will give the Capitol plant a battery of 16 B. & W. boilers, rated at 571-hp. each. Other material is arriving daily. The old Scotch-type boiler plant of the Printing office is to be scrapped.

Georgia Company Increases Capacity of Substation

THE GEORGIA RAILWAY and Power Co. has increased the capacity of its Boulevard Substation, which at the time it was built, in 1913, was the largest outdoor substation in the world and among the highest in voltage. The new equipment to be added has been ordered from the Westinghouse Electric & Manufacturing Co. and consists of three 3333-kw. oil immersed, water-cooled transformers and one 400-amp., 110,000-v oil circuit breaker.

The Boulevard Substation, when built, was laid out for an ultimate rating of 60,000-kv.a., stepping down the energy received from the Tallulah Falls hydroelectric plant at 110,000 to 19,000-v. star. Originally only 30,000-v. were installed in the substation, but the growing load around the Atlanta district made necessary further development.

Business Activity Maintained During September

INDUSTRIAL ACTIVITY in September was maintained at about the same level as in other recent months, according to figures from the Department of Commerce Survey of Current Business which show that, with the resumption of coal mining and the settlement of the railroad strike, there has been increased activity in many industries. Iron and steel production recovered from the low point in August, although not yet back to the level of a few months ago. Unfilled orders for steel continued to pile up while prices of iron and steel increased sharply. Coal production in recent weeks has been fairly satisfactory, although but little reserves have been accumulated against the demands of colder weather. Bituminous production is clearly limited by transportation facilities.

The railroad situation is becoming more and more the key to industrial activity. In addition to the shortage of cars for coal, reports indicate that movement of crops, building material and other products are being delayed. Many movements, including building construction, automobile production, and certain foodstuffs, are showing the effect of seasonal conditions. Prices remained relatively steady, with advances in some groups offset by declines in others. Employment continued its advance toward normal, reaching in September its best condition since December, 1920, as regards New York state. Pennsylvania showed the best condition since data for this movement have been available for that state, that is, April, 1921. United States postal savings continued to decline.

J. J. FORBES, coal-mining engineer of the Bureau of Mines, is collecting data for the preparation of a bulletin on sampling and analyses of Alabama coals. This bulletin will give information regarding the coals of the Birmingham district. One hundred and forty-nine face samples of coal have been taken in 34 mines in Alabama, representing 14 different coal beds.

IT IS LEARNED that the Alaska Pulp & Paper Co. is to construct a timber dam, and power plant at the outlet to Tease Lake. Manager W. P. Lass said that the dam is to assure power for the Speel River mill, located near Smettisham, Alaska, which is now employing 30 men.

News Notes

JOSEPH W. ROE was re-elected president of the Society of Industrial Engineers at the ninth annual convention held in New York, Oct. 18, 19 and 20. Prof. Roe is a member of the Executive Board of the American Engineering Council and head of the Department of Industrial Engineering at New York University. F. C. Schwedtman, vice-president of the National City Bank of New York, was re-elected treasurer and George C. Dent, of Chicago, was continued as secretary and business manager.

JOHN FORREST KELLY, prominent electrical engineer in Western Massachusetts, died Oct. 16 at his home in Pittsfield, Mass. He held more than 90 patents for generating, transmitting, utilizing and measuring electricity and was a pioneer in the work of long distance high tension transmission of current. He founded the Tellectic Co., of Pittsfield, Mass., and was its president from 1905 to 1910. He was a graduate of Stevens Institute, Hoboken, N. J., and was for a time an assistant to Thomas A. Edison, specializing in chemistry of rare earths. He was also engineer of the New York branch of the Western Electric Co and carried on research work in New York in high resistance alloys of very low or even negative temperature coefficients. He leaves a widow and two children.

THE DIVISION OF ENGINEERING of the National Research Council has just issued a booklet giving much information about its organization, work and personnel. This is a co-operative organization of American societies and scientific men concerned with the physical, mathematical and biological sciences, and the applications to human welfare through the agricultural, engineering and medical arts. Approximately 80 societies are included. Among the council's members are also business men interested in the industries.

The Division of Engineering has offices in Engineering Societies Building, 29 West 39th St., New York, in order to facilitate co-operation with the engineering societies and Engineering Foundation.

CHARLES RUSS RICHARDS, former Dean of the College of Engineering of the University of Illinois, a member of the American Society of Mechanical Engineers, and a member of the Council 1919-21, was inaugurated president of Lehigh University on Oct. 14, Founders' Day for the University. In his inaugural address President Richards indicated that Lehigh would embark on the work of engineering research.

ORDERS CALLING for the substitution of 70-T. trucks in place of 50-T. trucks under 10,000 coal cars have been issued by the Pennsylvania Railroad for execution in its Altoona shops. This action, by increasing the capacity of the cars by 40 per cent, will materially aid the rapid movement of coal on the system.

ENGINEERING and power improvements are assured the citizens of Petersburg, Virginia, during 1923. The Virginia Railway & Power Co. is to co-operate with the city in paving streets and putting in new track improvements. The city is to spend $150,000, while the power company will spend about $400,000 on improvements. Power plants and equipment will be enlarged and improved to the amount of $250,000 of the total above. Plans call for the proposed extension of the high power transmission line from Petersburg to Norfolk. This is dependent upon arrival of materials.

Actual work is expected to begin early in 1923. With the eventual completion of the line, the plant at Richmond will be expanded by the installation of a 20,000-kv.a. unit, enabling the company to supply current between Richmond and Norfolk. Other improvements besides those announced will bring the power company's 1923 budget up to the $1,000,000 allotted.

ONE OF THE REASONS why copper shipments abroad have shown a substantial decrease within recent weeks is the fact that Japan has placed a practically prohibitive tariff on the metal. The continued decline in the value of the mark has caused a reduction in the volume of German buying. Both Germany and Japan have been the two countries that have been taking most of America's copper, outside of domestic consumption.

WHEN AN ENGINE raced at the Farrell, Pa., plant of the Carnegie Steel Company, the power of the 6000 hp. engine upon which the mill depended was shut off. The 80-ton flywheel loosened by the accident, flew into space via the roof, and a 20-ton fragment landed in the adjoining ball park.

O. P. HOOD, chief mechanical engineer of the U. S. Bureau of Mines, has just returned from a trip to Europe, where he has been investigating lignite mining and preparation as a background for work of the Bureau in this country.

E. B. POWELL, of Stone & Webster, Inc., of Boston, sailed Oct. 28 on the Majestic to make a study of recent developments in European power plant practice. He expects to visit England, France and Germany and to return to this country early in December.

WORK HAS BEEN STARTED by Dwight P. Robinson & Co. on the design and construction of an extension to the plant of the American Rolling Mill Co. at Ashland, Ky. The extension will include a jobbing and sheet mill, and a galvanizing plant. Another contract which has been awarded this organization is for the construction of a cement mill at Birmingham, Ala., for the Lehigh Portland Cement Co. of Allentown, Pa. The mill will have a capacity of 1,000,000 bbl. a year.

W. S. GORDON, for the past 12 yr. with the molding department of the Bakelite Corporation, has been appointed sales manager of the molded products division of the Johns-Pratt Co. Mr. Gordon will make his headquarters at the factory in Hartford, Conn., and thus not only keep in close touch with the sales, but the factory production of the molded products.

ANNOUNCEMENT HAS BEEN made by the Harrisburg Foundry & Machine Works, builders of unaflow and piston valve engineers, that Frank F. Boyd has been appointed general sales manager and Albert E. Gastrock, assistant general sales manager.

C. G. BROWN, Professor of Electrical Engineering in the Collegiate Department of the School of Engineering at Milwaukee, has accepted a position with the General Electric Co. in the General Engineering Laboratory, of which L. T. Robinson is Engineer in Charge. His work

will be in connection with Instruments, Meters and Measurements.

Mr. Brown is a member of the American Institute of Electrical Engineers, Society for Promotion of Electrical Engineering, and the American Association of Engineers.

THE WESTON ELECTRICAL Instrument Co., of Newark, N. J., announces a new and unique line of small portable instruments for use on alternating current circuits, known as the "Weston, Jr." The group, described in Bulletin 2006, comprises wattmeter, voltmeter, ammeters and milliammeters which will undoubtedly fill a real need in the factory, the isolated power plant, the central station, the laboratory of the educational institution for field testing, because they are very compact, light in weight and inexpensive in cost.

D. C. SPENCER is leaving his position as sales engineer with the American Engineering Co. to go with Geo. W. Edwards & Co.

THE JOHNS-PRATT Co. of Hartford, Conn., announces the appointment of L. F. Carleton as district sales manager, electrical division, with offices in Boatmen's Bank Bldg., St. Louis.

THE WESTON ELECTRICAL INSTRUMENT Co. of Newark, N. J., announces that G. P. Atkinson, for several years connected with its home office sales organization, has opened an office in Atlanta, Ga., for the territories of Georgia, South Carolina and Northern Alabama. In addition to Weston instruments, Mr. Atkinson has several other nationally recognized lines of electrical equipment.

AN APPLICATION FOR the right to create a note indebtedness of $20,000,000 to retire existing debentures and for other unannounced purposes was filed with the state railroad commission Oct. 14 by the Western States Gas & Electric Co. It is proposed to obtain at once a note for $5,000,000 of the amount at 6 per cent interest to retire $2,668,000 in 10-yr. 6 per cent notes and $1,199,000 in 5-yr. 6 per cent collateral trust notes. The remainder will be devoted to construction and other purposes.

ARTICLES OF INCORPORATION of the Geysers Development Co. of Delaware have been filed with the County Clerk of Sonoma County. This is a corporation of $500,000 capitalization, formed to exploit The Geysers, a Sonoma County natural wonder located a few miles northeast of Cloverdale, Cal. Experiments are now being carried on there to harness the force of underground steam for the production of electrical power. Enormous steam pressure has been found 75 ft. beneath the surface.

AT THE ANNUAL convention of the district managers of the Pacific Light & Power Co., held at Hood River, Ore., it was announced that the federal power commission had just granted the Pacific Power & Light Co. a preliminary power permit for a reclamation power site on the Deschutes River, about 20 mi. from its mouth. The site is capable of developing about 30,000 kw., and a plant there will cost an estimated $5,000,000.

A TRACT of 3.19 acres on Flynn St., between the plant of the Dallas Power & Light Co. and the Dallas Cooperage Co., was purchased recently by the Dallas Power & Light Co., of Dallas, Texas. This property will be used as a location for the extension to the present plant, which the company will build at a cost of $2,180,000. Work on the new plant will start about Jan. 1 and will take about 2 yr. for completion, according to Joe H. Gill, assistant general manager. The capacity of the present plant is 22,000 kw. and the extension will increase this to 37,000 kw.

FRANK E. SHEPARD, president of the Denver Engineering Works, recently addressed the Denver Civic and Commercial Association on "Developing the Resources of the State."

THE POTOMAC PUBLIC Service Co. is to erect a new steam power plant at a cost of $150,000 at Williamsport, Pa. After construction had been started, recent commitments of the company made a change necessary, so the expense is to be increased and the proposed capacity doubled before the plant is opened for service.

WORK IS TO be started at once on two power plants to be erected along the diverted Whitewater River, north of Banning, Cal., for the San Gorgino Power Co. One plant will be located at Big Oaks and the other at Camp Comfort. The estimated cost is $500,000. A third plant, to cost $400,000, is being planned, it is reported. The Southern Sierra Power Co. will purchase the electrical energy developed.

THE MALLISON FALLS POWER Co. has leased the water rights of the Windham Manufacturing Co. on the Presumpscot River and is now building a new $100,000 power plant of 1000 kw. capacity at Windham, Maine. The H. P. Cummings Construction Co., of Portland, is building the plant, the General Electric Co. is furnishing the machinery and the Morgan Smith Co. the water wheels. It is expected that the new plant will be ready the first of the year.

PREDICTIONS OF THE use of electron tubes for transmitting power in great quantities have resulted from the recent substitution of these tubes for alternators in transmitting wireless telegraph messages across the Atlantic from the plant of the Radio Corporation at Rocky Point, L. I. A successful 16-hr. test was run, and it was said that the change from alternators to electron tubes made no difference in receiving or sending of messages which was noticeable to the operators. Six metal, water-cooled tubes having a capacity of 20 kw. each were employed. These tubes are the result of the work of Dr. Irving Langmuir, research engineer of the General Electric Co.

NEWS OF THE COAL situation during the early weeks of October showed a return of production to a high level, coupled with effective work on the part of the railroads. Reports to the American Railway Association show that the day's output of bituminous coal for Oct. 9 reached the highest figure recorded since December, 1920.

U. S. CIVIL SERVICE COMMISSION states that it will receive applications until Dec. 5 to fill positions of inspector (mechanical) at the Naval Station, Pearl Harbor, T. H. The pay offered is $7.20 a day with an additional allowance of 96 cents a day while employed at the station. Transportation is furnished by the Government. Competitors will not report for a written examination, but will be rated upon the subjects of technical education and preliminary experience (30 per cent) and special experience and fitness (70 per cent). A degree in mechanical or electrical engineering from a recognized college or university and at least 3 yr. of certain specified experience are required, except that 7 yr. of experience in mechanical engineering will be

accepted in lieu of a college course. Full information and application blanks may be obtained from the U. S. Civil Service Commission, Washington, D. C.

INAUGURATION OF ONE of the largest substations in the United States and the terminus of the highest voltage transmission line yet constructed, took place Oct. 23 with the official opening of the new Claremont substation of the Pacific Gas & Electric Co., in Oakland, Cal. From this station energy generated from the Pit River will be transmitted throughout the east bay district.

Books and Catalogs

THE WELDING ENCYCLOPEDIA, second edition, compiled and edited by L. B. Mackenzie and H. S. Card; size 6 by 9¼ in., 388 pages, 550 illustrations, flexible imitation leather, gilt edges; Chicago, 1922. A reference book on the theory, practice and application of the four autogenous welding processes. The first half of the book consists of a dictionary of all words, terms and trade names used in the welding industry. Included in this arrangement are instructions for welding operations on the most common types of repair work and production work, descriptions of the modern methods of testing welds, specifications for welding rods and wires for all classes of work, and descriptions of application of welding to the various industries, such as automobile repairing, refrigerating machinery, structural steel, etc. Following the Dictionary Section are separate chapters on Oxy-acetylene welding, Electric Arc welding, Electric Resistance welding and Thermit welding. Complete descriptions of each one of these processes are given, followed by general operating instructions and special instructions for the application of each process to every metal which can be welded by it. Separate chapters are included on the subjects of boiler welding, tank welding, pipe welding and rail joint welding. Another section is devoted to the rules and regulations enforced by Federal and State authorities and insurance companies, on the construction, installation and operation of welding equipment, and on their application to various structures. A special chapter deals with the heat treatment of steel, one of the most important metals which the welder handles. A collection of charts and tables shows the variety of methods of preparing joints for welding, gives information on the characteristics of all the commoner metals, shows how to tell the temperature of metals by a color chart, and also shows a color chart explaining the proper adjustment of the Oxy-Acetylene flame. The Catalog Section at the end of the book describes and illustrates the standard lines of welding equipment and apparatus.

BULLETIN CB1, issued by Combustion Engineering Corporation, of New York City, covers the performance of the Coxe stoker on western and mid-western bituminous coals. A number of test reports, each accompanied by corresponding curves, are included. These tests show remarkable results and because they are complete in every respect they will be of considerable interest to the engineering world. Three years ago it was thought impossible to burn bituminous coal on Coxe stokers or any forced draft traveling grate stokers. Today there are a number of successful installations in some of the biggest and most important plants in the middle west. Pictures of a number of them are shown in this bulletin. The Service Bulletin, while it is also issued by this company, will be of value to all stoker companies. At the present time it is necessary for stoker manufacturers to render, gratuitously, service of a very costly nature. This booklet presents the stoker manufacturers' side of the question and shows why a proper charge for real stoker service would not only be fair to the recipient, but would be to his advantage. It is illustrated with an interesting cartoon story.

HYDRAULIC FITTINGS are covered in bulletin 5020 which has been issued by the Hydraulic Press Mfg. Co., Mount Gilead, Ohio.

THE MOST RECENT publication covering Type SC single stage, double suction pumps, manufactured by Dayton-Dowd Co., has just been received.

HEAVY DUTY Corliss engines, made by Allis-Chalmers Manufacturing Co., Milwaukee, Wis., are illustrated and described in Bulletin 1529-B, just received from that company.

THE GREAT OUTDOORS BROUGHT INSIDE is the title of a booklet sent out by the Burt Manufacturing Co., of Akron, Ohio. The booklet takes up the proper ventilation of buildings and describes the company's line of ventilating apparatus.

AN INSTRUMENT called the Kritiskope, which determines by magnetic means the proper temperature of steel in heat treating processes, is described in a bulletin issued by Herman H. Sticht & Co., 15 Park Row, New York City. Another folder issued by the same company covers a megohmer.

THE LINK-BELT CO. of Chicago, Philadelphia and Indianapolis announces the completion of a new general catalog No. 400 which embraces their entire line. It is the most complete book they have ever issued on this subject. It contains 832 pages, is cloth bound and can be obtained from any Link-Belt branch office.

DATA regarding the softening temperatures of coal ash from several hundred coals from the different fields of the country are contained in Bulletin 209, "Fusibility of Ash from Coals of the United States," by W. A. Selvig, assistant analytical chemist, and A. C. Fieldner, supervising chemist, just issued by the U. S. Bureau of Mines.

THE ADVANTAGES derived from arc splitters in conjunction with the magnetic blow-outs of contactors are explained and illustrated in a publication, known as Leaflet No. 3429, lately issued by the Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa.

The life of a controller is dependent to a large extent upon the design of the magnetic blowout which is used for rupturing the arc that is established when the controller contacts are separated under load. The magnetic field must have the correct strength and shape to reduce the wear on the contacts and prevent the arc from burning the other parts of the contactor.

An arc splitter materially assists in rupturing the arc by cooling it and also by causing it to form two or more loops which have a total length within a given magnetic field that is much greater than the length of a single loop.